An investigation as to how a computerised multimedia intervention could be of use for practitioners supporting learners with Autism Spectrum Disorder (ASD)

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A thesis submitted to Middlesex University
in partial fulfilment of the requirements for
the degree of Doctor of Philosophy

School of Health and Education
Middlesex University
London, UK
September, 2017

Abstract

This practice-based action research investigation seeks to make a valuable, original and academic contribution to knowledge in the computing, language, communication and educational fields. The aim was to establish the therapeutic (language and communication skills) and educational (literacy and numeracy skills) use of individual tailored computer games for practitioners supporting learners (end-users) with Autism Spectrum Disorder (ASD). This was achieved through a continuous collaboration of cohorts of computing undergraduate students and academics (the development team) carrying out an assignment for a module designed and successfully led by this PhD student (the researcher). The researcher continually collaborated with practitioners (users – teaching staff and speech and language therapists in schools) of learners with ASD over many years.

The researcher developed a Computerised Multimedia Therapeutic/Educational Intervention (CMT/EI) process, which used an iterative holistic Design-For-One approach for developing individual computer games. An action research methodology was adopted using methodological triangulation 'quantitative' and 'qualitative' data collection methods. This was to ascertain as to how tailor-made computerised multimedia games developed, could be evaluated by the users as being of therapeutic/educational use for their learners (end-users) with ASD. The researcher originated profiles to establish the diversity of each learner's spectrum of therapeutic/educational autistic needs, preferences, capabilities, likes, dislikes and interests. The researcher orchestrated, collaborated and supervised the whole process from individual profiles completed by the practitioners, through to the profiles used as a baseline, by the development team, and to the designing, developing and evaluating iterative customised personalised computer games.

Four hundred and sixty-four learners with ASD (end-users) and forty-nine practitioners (users) from nine educational establishments across the UK participated in this investigation. Two stages were carried out in an initial application procedure (with one school) and prototype procedure (with a further six schools and 2 educational establishments).

Stage I - Planning, collection, organisation, Design-For-One approach and development. Stage II - Testing, Evaluation, Monitoring, Reflection and Maintenance. Optimistic ‘quantitative’ and ‘qualitative’ evidence emerged (using content analysis) from the implementation of games in the classroom and the practitioner’s therapeutic and educational evaluation of storyboards and games. The documented positive findings led to a conclusion that personalised games which had been developed over a ten-year period, showed to be of therapeutic/educational use to practitioners and their learners with ASD.

Acknowledgements

My thanks go to my supervisor (Dr. Annette Fillery-Travis) for her guidance with the investigation. Thanks go to the School of Science and Technology's staff and colleagues for their encouragement with the development, leading to the success, of my module (with the inclusion of Autism). I would like to acknowledge and thank the cohorts of students for studying my module over the years. Special thanks go to Professor Anthony White, Dr. Shivani Sharma, Dr. Ceri Smith, Davina Foster and Kathy Roe, for all their hard work. My thanks also go to all the practitioners in the schools and learners who participated in the investigation. I would like to thank all my friends (past and present) for their support and encouragement to carry on and complete this work. Special thanks goes to all my family, my husband Richard, my son Daniel (Dan), daughter-in-law Clare and granddaughters Abigail May (Abbie) and Matilda Grace (Tilly), my daughter Victoria (Ria) and son-in-law Wayne, my sister Anne and my sister-in-law Margaret, for putting up with me through my ups and downs whilst carrying out this research over the years. Finally, a very extra special thanks to my daughter Katie, who is on the autism spectrum and who gave me the inspiration for carrying out this work, teaching and helping me to understand so much in order for me to achieve this work…

…now, others can also be taught and helped from this investigation.

Glossary of Abbreviations

AAATE	Advancement of Assistive Technology in Europe
AAC	Alternative Augmentative Communication systems
ADHD	Attention Deficit Hyperactive Disorder
AI	Artificial Intelligence
AR	Action Research
ASD	Autism Spectrum Disorder
BCS	British Computer Society
BECTA	British Educational Communications and Technology Agency
BSc	Bachelor of Science
CAI	Computer Aided Instruction program
CAL	Computer Aided Learning
CAR-E	Collaborative Action Research in Education (CAR-E)
CC	Computer Club
CD	Compact Disk
CMT/EI	Computerised Multimedia Therapeutic/Educational Intervention
DfEE	Department of Education and Employment
DT	Development Team
ETSI	The European Telecommunications Standards Institute eEurope
End-users	Pupils/Learners
EIW	Electronic Interactive Whiteboards
FE	Further Education
HCI	Human Computer Interaction
HE	Higher Education
H/S	Home/School environment
HTA	Hierarchical Task Analysis
IBI	Intensive Behaviour Intervention
ICT	Information & Communication Technology
IEP	Individual Educational Plan
IT	Information Technology
ITHACD	Individualistic Tailored Holistic Autism Centred Design
IQ	Intelligent Quotient
LEA	Local Education Authority
MIDI	Musical Instrument Digital Interface
MLD	Moderate Learning Difficulty
MT/EI	Multimedia Therapeutic/Educational Intervention
NAS	National Autistic Society
NIDCD	National Institute on Deafness and other Communication Disorders
OT	Occupational Therapists
PAR	Participatory Action Research
PD	Participatory Design
PC	Personal Computer
PECS	Picture Exchange Communication System
PgCert(HE)	Postgraduate Certificate for Higher Education
QCA	Qualification Curriculum Authority
RAD	Rapid Application Development
RASatE	Recent Advances in Assistive Technology and Engineering
SALTs	Speech and Language Therapy/Therapists
SENDCO	Special Educational Needs Disability Coordinator

SIGN	Scottish Intercollegiate Guideline Network
SPELL	Structure, Positive, Empathetic, Low arousal and Links
TEACCH	Treatment and Education of Autistic and related Communication -handicapped CHildren
TD	Typically Developing
TEL	Technology Enhanced Learning
UCD	User Centred Design
UK	United Kingdom
Users	Practitioners – Teaching staff, Therapists, Psychologists
VOCA	Voice Output Communication Aid
VST	Virtual Studio Technology

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Chapter 1
Introduction to Thesis

1.1 Overview to this chapter

This thesis presents an action research practice-based project to investigate whether a computerised multimedia intervention is useful and of benefit/value for practitioners (users – teachers, teaching assistants, speech and language therapists, educational psychologists) supporting learners (end-users – pupils) with Autism Spectrum Disorder (ASD). The reason the term 'users' is used in this investigation for the practitioners was that, the intervention (computer games) would be developed in collaboration with them as they had the expertise and understanding of each learner's needs. For an intervention to be used by learners (end-users) it would be the practitioners (users) who would evaluate its potential benefit/value. This would result in their decision as to whether it should be implemented in the classroom. The aim of this research was to investigate the therapeutic and educational use of tailored software (computer games). The term 'therapeutic' is used in this investigation as some of the participants (practitioners), were speech and language therapists with some medical knowledge. It is also used to indicate an enhancement of learners on the autistic spectrum disorder's (ASD's) language and/or communication skills. The term 'educational' is used in relation to the enhancement of the learner's literacy and/or numeracy skills. The objectives of this research were:

- to adopt an iterative collaboration with practitioners
- to ascertain from practitioners the variance of each learner on the autistic spectrum's details and their needs
- to adopt a holistic, Design-For-One approach to the design.
- to enable a multimedia software (gaming) development team (university students and academics) and practitioners to evaluate the computer games for quality control before implementation in the classroom.
- to enable the process to be carried out with large groups of participants on an iterative basis.

Simultaneously a university module and assignment was constructed which enabled large cohorts of students to develop games for research purposes that would be of use (benefit/value) to real users and end-users in society. This is contrary to the production of an assignment just for grading purposes. The researcher sought to demonstrate that this process of involvement with the end-users needs would stimulate, motivate and be of value to the students. This is the first-time software (games) had been developed for large numbers of learners (end-users) using profiles of the end-user needs, completed (Tables 5.1-5.6:131-140) by practitioners (users) working with these learners. These profiles were used to identify each learner's individual details, spectrum of needs etc. The rationale for this project was to use a holistic Design-For-One approach to develop and implement individualised therapeutic/educational computer games for each end-user on an iterative basis.

Two procedures were used for the Computer Multimedia Therapeutic /Educational Intervention (CMT/EI) process. Firstly, an initial application procedure, which developed individualised computer games for one school and then a prototype procedure with the involvement of other schools. The iterative process consisted of two stages. Stages I **-** Planning, collection, organisation and action (design and development) and Stage II – Testing, Evaluation, Monitoring, Reflection and Maintenance. As the sole coordinator of the project the researcher's personal and professional assumptions, perceptions, experiences, plus a variety of knowledge and understanding of the special educational needs, academic and multimedia worlds were significant in planning, informing and developing this research.

1.2 Personal understanding

The researcher's assumptions came from a personal experience, and understanding over many years of the special educational needs world. This was through raising a 27-year old daughter with Autistic Spectrum Disorder (ASD), numerous complex medical problems, severe behavioural problems and learning disabilities.

Her daughter attended special schools and learnt the Makaton sign language through speech and language therapy (SALT). There were, however, limitations in relation to speech and language therapists and therapy. Her daughter has a spectrum of needs with numerous likes, abilities and specific interests and is especially very stimulated and motivated by multimedia games. Accordingly, in view of the learner's interest in computers and the lack of SALT, the researcher wanted to explore if practitioners would use computers games for enhancing therapeutic and educational skills.

1.3 Understanding of Practitioner's knowledge

Working with practitioners (teachers and therapists) over a long period has helped the researcher to understand schools' ethos, curriculums, therapeutic (language and communication) and educational (literacy and numeracy) needs, low and high tech interventions and further her understanding of learners on the ASD. The practitioner's (user's) have extensive knowledge, expertise and understanding of each end-user's diversity and spectrum of needs, likes, dislikes and interests. This was increased by comprehending the statements described and discussed by the practitioners and through their completion of blank profiles, which had been designed by the researcher. This enabled her to identify areas of concern relating to the end-user's individual therapeutic and educational needs, likes and interests. The researcher realised that learners were using generic software (games) in the classroom, which had not been developed in collaboration with users and did not consider the individual end users and their range of needs.

1.4 Professional understanding

The researcher has also professional and technical experiences within the academic world. This was acquired from studying Information Technology and Education Studies at degree level, a PgCert.(HE) and her development of professional multimedia technical knowledge and research. She has also taught many cohorts of university students over 18 years. Her further academic duties were as a Special Educational Needs and Disability Coordinator (SENDCO) in the university, giving rise to many UK and international publications.

The researcher's continuous reflection on pedagogy identified to her that some students put a lot of effort into their coursework to pass their studies whilst others did the absolute minimum. Some students, however, were not stimulated or motivated to put any effort into their work. In addition, some students' coursework was eventually binned or gathered dust and was not of any use to the student or anyone else. Her experience as a multimedia practitioner, Module Leader, Lecturer and Tutor has given the researcher the professional and technical knowledge which enabled her to research and justify whether computerised multimedia games could be developed and used as a therapeutic/educational intervention for practitioners (users) working with learners with ASD (end-users).

Through the researcher's personal and professional knowledge, experience, skills, and expertise and the in-depth literature review (Chapter 2:8) she has become familiar with the complexity of the role of the researcher (as both an insider and outsider) in this investigation (Souto-Manning and Mitchell, 2010; Bowling, 2006).

Accordingly, the researcher agrees with Gummesson's (1991) claim that personal and professional understanding gained over time have led to the awareness of the context of research and the problematical areas and in turn, enabled the investigation to gain a richer perspective. This research explores the possibility of alleviating some of the users' difficulties such as finding games, which were therapeutic/educationally and appropriately developed for their learners whilst taking the diversity and spectrum of needs of end-users into consideration. The researcher's knowledge and experience gave insights, which might not have been available to other investigators. The remaining part of this chapter provides a summary of each chapter and maps the content and structure of the thesis.

1.5 Introduction to Chapter 2 – Literature Review

Chapter 2:8 examines the variance learner's spectrum of language and communication (therapeutic) and literacy and numeracy (educational) needs.

It researches into autism, teaching, interventions, low and high-tech Alternative Augmentative (AAC) systems and play highlighting these learner's preferences for computers. It explores whether computer games had been developed using an iterative and individual approach. This would be achieved with a holistic baseline of the diversity of each end-user's spectrum of needs, their details, their modalities, channels of communication, multimedia element preferences, their capabilities, likes, dislikes, strengths, weaknesses and interests. A baseline will be used through the continuous collaborations with the practitioners (e.g. teachers and speech and language therapists – users) supporting learners with ASD (end-users). This research highlights these learners' needs for structure, routine, predictability and highlights gaps and concerns in previous research studies.

1.6 Introduction to Chapter 3 – Research Methodologies

Chapter 3:64 looks at the researcher's ontological assumptions, epistemological viewpoints and the research knowledge gained from studying a variety of methodologies. This led to the discussion, justification and adoption of McNiff's (2013) Action Research (AR) as the primary chosen methodology. The researcher regarded this approach as being appropriate to answer the research questions and to meet the aims and objectives from the gaps and concerns found in the literature review. The researcher adopted McNiff's (2013:57) action research methodology of 'spontaneous, self-recreating, extended iterative systematic action-reflection, spiralling theory using the in-sequential or necessarily rational process' observe, describe, plan, act, reflect, evaluate and modify.

The researcher's personal and professional experience and acquired understanding enabled her to structure the investigation through a controlled, monitored and evaluated process to apply computerised interventions as a way of finding a solution to support users and improve their learners therapeutic/educational needs. This investigation introduced, planned and structured the production of multimedia computer games through a change in academia by developing a successful module and assignment.

1.7 Introduction to Chapter 4 – Product Design

Chapter 4:88 explores design guidelines, principles (heuristics), processes and approaches (Table 4.1:94). The chapter explains how batches of computer games were designed and developed through Action Research (AR) cycles of a Computer Multimedia Therapeutic/Educational Intervention (CMT/EI) process using two stages and the Initial Application and Prototype procedures. Individual computer games were developed by continuous cohorts of university students carrying out an assignment from a successful module originated by the researcher over many years. Personalised computer games were developed by students using profiles completed by practitioners (teachers and speech and language therapists (users) over ten years.

The chapter describes how the objectives were met using a cyclical Design-For-One approach. It explains how the students, the researcher and the users had achieved a quality control method. The investigation explains ethical issues, generic computer games, implementation and testing of individualised games, the diverse quantitative and qualitative data collection methods and a content analysis approach (Elo and Kyngäs, 2008, Figs. 5.1-5.3:133-134).

1.8 Introduction to Chapter 5 – Results

This chapter (page 129) gives an explanation as to how practitioners (users) evaluated and assessed whether the individual computer games would be therapeutically beneficial and/or of educational value for their learners (end-users) before they were implemented in the classroom.

The chapter gives an explanation, with examples of how a content analysis approach (The researcher's diagrammatical approach – Figs. 5.1-5.3:133-134) used documented qualitative findings from the completion of profiles, initial evaluation sheets, diaries, interviews, questionnaires by the users and non-participant observations by the researcher based on storyboards and individual computer games.

1.9 Introduction to Chapter 6 – Discussions and Conclusion

The chapter (page 193) provides a critical discussion and reflection on the essential findings of the research and extracts conclusions for the study. It revisited the extent each objective of the research had been met in the light of the literature review (Chapter 2:8) findings. This was whilst giving evidence from the analysis of the quantitative and/or qualitative methods based on the individual computer games developed in this investigation. This empirical practice-based action research was achieved through the continuous collaboration, input and evaluation by large groups of participants (Schools, users and end-users). This was to demonstrate how the main aim (to ascertain the therapeutic (language and/or communication) and educational (literacy and numeracy) concerning the use of individualised tailored computer games, had been met.

It discusses how this was achieved on a continuous basis by cohorts of students carrying out an assignment of a module originated by the researcher over many years using an iterative holistic Design-For-One approach, within a CMT/EI process.

This chapter corroborates how the gaps and concerns have been met from the results of the findings from the evaluation by the users and through implementation and testing the games. Conclusions are drawn from the overall evaluation of the practice-based action research (AR) project. Future possibilities, limitations and recommendations are specified.

Explanations are given as to the valuable, original, academic contribution this research has made to new knowledge in the computing, therapeutic and educational fields.

Chapter 2
Literature Review

2.1 Introduction and structure of the chapter

The investigation needed to determine, from a critical examination of the literature review findings, the diverse needs of learners on the autism spectrum (end-users) (Kemp, 2010b). This was to ascertain if an effective method of producing individual computer software could be developed to address these needs, through the collaboration with large groups of practitioners (teachers/speech and language therapists - users) for large groups of learners with ASD (end-users).

This chapter looks first at the symptoms and impairments of autism and begins with a general background on language. It discusses the triad of impairments (Fig. 2.1:9), exploring the variance in these learners' autistic needs and their characteristics. This led to a discussion on the difficulties they have with play and ending the section with a discussion on Language and Communication.

It then examines early educational interventions and how learners learn in relation to the environment and surroundings. It looks at the input from practitioners and the curriculum used in the classroom before looking at computer hardware and the teaching staff's concerns and limitations such as availability, lack of time and skills. It ends with a discussion on the advantages and disadvantages of therapeutic/educational computer hardware and software.

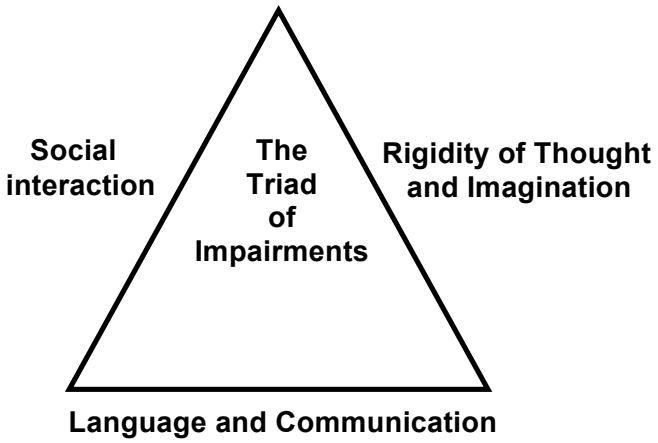
The chapter continues to discuss the use of Information and Communication Technology (ICT) and Computer-Assisted Learning (CAL) in schools including multimedia modalities and elements for stimulating and motivating learners. The chapter ends with the investigation exploring generic computer software, the therapeutic/educational benefits of multimedia software and the areas, which software developers should take into consideration.

2.2 Symptoms and Impairments of Autism

According to Wills and Evans (2016), there are over 600,000 people with Autism Spectrum Disorder (ASD) in the United Kingdom. Research has shown that there are four times more boys than girls having a diagnosis of ASD (Wing, 2010; Johnson et al. 2011). In 1944, Leo Kanner used the term 'Early Infantile Autism' (Faras et al. 2010). Wing (1996) in 1981 coined the term Autistic Spectrum (Frith, 1989; Cederlund et al. 2010). Some learners are just classed as having autistic tendencies, whereas, others are high functioning with servant abilities (Treffert, 2009; Suzuki et al. 2011). Children, therefore, need to be assessed based on the individual's 'strengths, impairments, skills and needs' (Yates and Couteur, 2013:5).

Researchers (Tirraono, 2011; Yates and Couteur, 2013) claim that there are difficulties diagnosing ASD. This is due to these individuals showing a variance in their degree of behaviour, language and intellectual abilities, symptoms and impairments. Learners with autism have a varying degree of the 'triad of impairments'. This consists of difficulties with social interaction, language and communication, the rigidity of thought and social imagination, in addition to emotion and behaviour impairments (Fig.2.1:9; Wing et al. 2012; Yates and Courteur, 2013; Kamaruzaman et al. 2016).

Fig. 2.1 The Triad of impairments



This investigation agrees with Wood-Robinson (2009) and Kemp, (2010b) that it is important to find out each learner's triad of impairments for the appropriate intervention to be implemented and begins with a discussion on social interaction.

Social Interaction

A difficulty with social relationships often restricts these individual's comprehension of turn-taking and lack of perception of the non-verbal complex rules of social interaction (Park et al. 2012; Yates and Courteur, 2013). Some appear aloof, yet have good non-verbal skills. Their inability to interact with others and interpret emotion, facial and body signals from others, result in misunderstanding social behaviour (Stichter et al. 2010; Varga, 2011). This social impairment could be due to their difficulties with the rigidity of thought and social imagination and in deciphering and coping with a confusing, challenging, changing and interactive society, consisting of boundaries, order and meaning (Lanou et al. and Wing et al. 2012).

Rigidity of Thought and Imagination (Social)

Some learners do not understand what someone else is thinking (Lanou et al 2012). Furthermore, O'Connor and Stagnitti (2011) claimed that often language skills are practiced through imaginative play, which is difficult for some of these learners. Whereas, some learners find social situations frightening and unpredictable because they may have a combination of impairments (Kemp, 2010b; Yates and Courteur, 2013; Fig. 2.1:9).

Play

The characteristics of play (Garvey, 2004) consist of the active engagement of a player interacting in a voluntary, spontaneous, pleasurable way with no goals imposed on them from outside, helping learners' social communication (Christensen et al. 2010).

Kemp, (2010d) study on the facilitatory play of eight preschool learners with autism and claimed that:

> learners need good listening and attention skills to develop speech and language and one way they can acquire these is through interactive play.
>
> Kemp, (2010d:34)

Varga, (2011) and Freeman and Kasari, (2013) highlighted that some learners had difficulties in engaging the interests of others in their play. They regarded play as having a passive solitary quality rather than being an interactive, collaborative, engaging experience with others. This investigation suggests that some learners' impairment in their rigidity of thought and social imagination (Wing et al. 2012; Yates and Courteur, 2013) may result in their difficulty in facilitating play. From the researcher's understanding, some learners respond better to structured play than a free spontaneous approach, which could make them more apprehensive and agitated due to their need for security from a repetitive structure and consistency (Volkert and Vaz, 2010).

Sherrattt and Peter, (2002), Freeman and Kasari, (2013) and Kasari, et al. (2013) stated that some learners need to be taught symbolic pretend play through structure, pleasure, interests and language. This would also be taken into consideration together with their diversity of speech and language (Schopler and Mesibov, 2013) as a baseline for the development of interventions in this investigation.

Language and Communication

The purpose of this research does not cover the theories or areas relating to language and communication development, such as the multilingual communities, the history of words, dialects and the differences between languages, etc. as this was not the focus of this investigation. For this study, it was important to provide readers with enough basic information for a greater sensitivity to this investigation.

The term ‘functional’ is defined by thesaurus as being, ‘useful’, ‘practical’, ‘handy’ or ‘purposeful’. The term ‘verbal’ is used in this research, as defined by thesaurus, as being ‘spoken’, ‘oral’, ‘vocal’ or ‘communicative’. The term ‘functional verbal language’ has been used in this investigation for learners who produced purposeful speech in the form of words and sentences for communication and language. Research indicates that some learners have difficulties acquiring and developing functional speech (Tager-Flusberg et al. 2005; Norrelgen et al. 2015) and language (The National Autistic Society, 2005a, 2005b; Frea, 2010; Richardson, 2015). Others use ‘you’ when referring to themselves, with some individual’s use of language being extremely literal, yet others have continuous one-sided limited monotonous responses (Jordan, 2013). Communication through verbalisation is an area of difficulty for many of these learners (Matson et al. 2012). Some learners find it difficult to begin a conversation, turn-taking and/or have difficulty understanding questions (Macaskill, 2005; Park et al. 2012).

Mayes’s (2003) analogy of learners with ASD with speech and language difficulties is that they hear speech as if it is controlled by the volume knob of a radio turned back and forth with the listener only picking up parts of the speech. These difficulties often cause behavioural problems due to their communication and social interaction difficulties with others (Yates and Courteur, 2013). Some verbal learners with ASD also have communication difficulties with semantics (meaning) and pragmatics (social language) (Volden et al. 2009). It is more difficult for some of these learners to communicate with others and understand the reaction and feelings of others without speech (Fig. 2.1:9; Kemp, 2010c). Some learners interpret language literally, lack attentiveness and are not able to follow instructions (Ostmeyer and Scarpa, 2012). Dawson et al. (2008) and Dougherty, (2015) further state that some learners have great difficulty in learning to imitate actions and processing language. Some have difficulties with comprehension, meaning and purpose of communication in social setting and have a limited interest in others, resulting in adopting a non-standard use of language (NAS, 2010a; Vanvuchelen et al. 2011). Whereas, others, have great savant skills (Miller, 2005; Dawson et al. 2008).

Some learners use functional verbal language, whilst others use a combination of communicative vocal sounds (giggles, laughing, and 'mmmm….') and sign language (Blood et al., 2013). This investigation suggests that some learners have a range of ways of communicating their needs (Miller and Eller-Miller, 2005; Dawson et al. 2008).

Some learners rectify their communication difficulties by adopting some form or combination of non-verbal communicative methods (pointing, gestures, facial expressions, symbols, sign language and/or body language) to help them communicate and comprehend their environment (Ganz et al. 2012; Blood, 2013).

These literature review findings established that some learners on the Autism spectrum might have an assortment of speech and language difficulties resulting in their isolation (Inclusive Technology, 2004a, 2004b; Kemp, 2010a; Blood et al. 2013). The National Autistic Society (2005a, 2005b) and Law et al. (2012) emphasised the importance of establishing each learner's exact speech, language, and communication impairments in relation to their autism.

2.3 Therapeutic Interventions

Gascoigne's (2008) paper highlights the importance of a collaborative holistic multidisciplinary approach to therapeutic interventions with the focus being the learner. There was no discussion as to how the variance of each learner's autistic therapeutic, educational needs, behavioural difficulties and collaboration with the practitioners had been considered.

Wing, (1988) and Schopler and Mesibov, (2013) however proposed a more individualistic approach through establishing which type of therapy would be beneficial to each learner's language difficulties, due to their variation in their language acquisition and language development (Table 2.1:14).

Table 2.1 Variation in speech and language difficulties (Dawson et al. 2008; Schopler and Mesibov, 2013)

Learner's speech and language difficulties
Non-verbalisation
Verbalising yet lacking in content and information
Little or no pronunciation
Little initiation of communication
Difficulty effectively using language
Difficulty with words, meaning, intonation and rhythm
Repetitious or immediate or delayed echolalia
Delayed speech
Use of stock phrases
Use of learned scripts
Problems with words and sentences
Expressing things out of context
Inability to use sign language or gestures
Inability to use pronouns
Use of high pitched or robotic speech
Accelerated vocabulary in an area of interest
Ability to read

As identified by (NAS, 2010a, 2010b; Wilkinson, 2011) there is general agreement that no two learners' needs can be treated as identical. Table 2.2:14 shows how differences between two learners can be manifest Szatmari (2011) and Ploog et al. (2013).

Table 2.2 An example of the differences between two learners, extracted from profiles used in this investigation.

1st Learner	2nd Learner
Likes to touch and to be touched	Finds touch painful
Likes interacting with others	Prefers being a loner
Talkative (Verbal)	Non-verbal
Some eye contact	Lack of eye contact
Leads by the hand	Will not let an adult hold hands
Obsessive	Non-obsessive
Ritualistic	Non-ritualistic
Severe challenging behaviour	Passive
Echolalia	Non-repetitive
Food Fads	Eats normally
Toilet trained	Incontinent day/night
Hyper acuity	No hearing difficulties
Epileptic	Non-epileptic
Transition difficulties	Accepts change

There are many strategies (Prelock et al. 2011) already in use by practitioners for extending language development (Table 2.3:15) such as speech and language therapy.

Table 2.3 Strategies used for extending language development (Prelock et al. 2011)

Interventions used
Seeking help and advice from practitioners who had an interest in language
Becoming more aware of the specific difficulties applicable to learners
Not speaking for the learner or giving them answers but playing software with them instead
Extending their range of environments for communication
Building upon the learner's special interests, likes and strengths
Use of texts, photographs, pictures, symbols, sounds or written words
Making activities meaningful by taking the above into consideration

Speech and Language Therapy

The focus of this research is not to fully analyse the effects, strengths and weaknesses of speech and language therapy because this investigation acknowledges these well-established successful therapeutic methods. The literature review (Duffy and Healy, 2011) identified the aim of this therapy is to improve learners' verbal communication, gestural communication and symbolic communication.

Parsons et al. (2011) highlighted that traditional speech and language intervention therapy programmes, structured behavioural techniques, real-life situations, music therapy and sensory integration therapy have helped some of these learners acquire vocabulary and language structure. Nevertheless, research (NIDCD, 2003; Satterfield, 2013), demonstrates that for some learners the acquisition of speech is slow. However, improvements have been shown with the help of speech and language therapy using Alternative Augmentative Communication (AAC) systems (Checkley et al. 2010; Satterfield, 2013).

Low-tech AAC systems comprise of speech, written, body and sign language, symbols, gestures, charts, books, flash cards, toys, hand puppets and songs. High-tech AAC systems comprise of computerised communication technological aids for speech, language and communication development.

Some SALTs, however, use sign language, such as the Makaton sign language, as part of their speech and language therapy programme to help some learners therapeutically (Sheehy and Duffy, 2009)

Makaton Sign Language

Makaton sign language uses spoken language as a reinforcement and uses specific rules and simple line drawings for each sign. This is to ensure that the observer's attention is visually held and is used to help learners who have not acquired significant speech and are severely impaired in all communication (Mental Health Care, 2005). This portrays to their observer two forms of communicating something in parallel (speech and signing) (Sweetser, 2007) and is less likely that the observer will misunderstand both these channels of communication. The advantages of using the visualisation of Makaton sign language is that the learner is not forced to speak to communicate their wants and needs, helps them understand other's signing and gives clues without any form of aid or communication equipment (Kluth, 2003; Sheehy and Duffy, 2009).

This investigation highlights the drawbacks of sign language for these learners. Some learners would find it difficult to sign, as it would mean they would need to look in the direction of the signer to be able to comprehend the sign language and physically sign. Others unfamiliar with the Makaton sign language cannot interact with Makaton users. Even when people are familiar with Makaton, if a learner uses personalised unique, inaccurate or unpredictable signs, this can cause a breakdown of two-way communication, resulting in the learner's frustration with being misunderstood or not understood at all.

This study will collaborate with practitioners to ascertain if the learners are using sign language and will include and animate Makaton drawings in the development of individualised therapeutic interventions. Conversely, researchers (Landers et al. and Satterfield, 2013) have claimed signing for some learners, may be as difficult for them as speech, suggesting that their speech development could be helped with a combination of photographs, pictures, symbols, and written words.

Picture Exchange Communication System (PECS) symbols

Meadan et al. (2011) explains how some non-verbal learners can communicate their requests through visual aids such as symbols and pictures to make their needs understood. PECS was developed to help some learners acquire functional communication skills and is suitable for learners who do not attach meaning to words.

Researchers (Yarnall, 2007; Travis and Geiger, 2010) have claimed that the familiarity of the visual communication used in PECS helped some pre-non-verbal and verbal autistic learners with their spontaneous communicative, social deficits and interactive skills. This is achieved by learners using verbal language and simple line drawings, symbols, pictures, or photographs to form sentences on a board (Yarnall, 2007). Unfortunately, the PECS approach has drawbacks such as the reliance on pictures, nevertheless, it has equally shown (Flippin et al. 2010; Higbee and Sellers, 2011) to improve speech and communication. Magiati and Howlin's (2003) pilot study demonstrated how some less-verbal learners' initial slow progress of speech and language increased over time with the use of PECS. Some more verbally able learners, however, made greater speech and language gains initially, which then levelled out. This may be due to verbally able learners being more motivated and stimulated since PECS uses an exchange of text and graphics continually and interactively (Gordon et al. 2011). This method would work well with learners who are happy to socially interact with others and understand the purpose of this method.

This investigation questions, however, whether Magiati and Howlin's (2003) study had collaborated with practitioners and whether they had taken into consideration the variance of each learners therapeutic and autistic needs.

Furthermore, the Treatment and Education of Autistic and related Communication-handicapped CHildren (TEACCH) system has been said (Yarnall, 2007; Fornasari et al. 2012) to be highly compatible with the PECS system with its effectiveness in developing communicative understanding and verbal language.

Treatment and Education of Autistic and related Communication-handicapped Children (TEACCH)

TEACCH is a visual system using a picture and word schedule. Learners are taught and encouraged to independently view their schedule to help their transition with activities, tasks and location. Kamaruzaman et al. (2016) however, claimed that visuals increased some children with ASD's communication. Taylor and Preece (2010) noted limitation and problems with the use of the TEACCH (and PECS) approach in relation to the participants' fine motor abilities with this tactile physical approach.

The researcher's findings have acknowledged claims (Ogletree et al. 2007; Adams et al. 2012) as to the usefulness of conventional, non-computerised, low-tech therapeutic (speech and language) methods using sign language, symbols and/or speech-generating devices (Macaskill, 2005; Van der Meer et al. 2012).

The researcher queries whether the participants who have benefitted from these approaches and studies, have been particularly chosen as they are tactile learners, able to socially interact with others and do not have difficulties with the proximity of others. These approaches and studies do not highlight whether these areas were specifically taken into consideration when the participants were chosen.

The investigation explored whether interventions and approaches developed over the years had taken in to consideration if learners were using signs and symbols and would incorporate these into the development of therapeutic intervention in this investigation. Nevertheless, the therapeutic effectiveness of the low-tech methods (Adams et al. 2012) is not disputed and will be appropriately implemented for this investigation if stipulated by the practitioners. Parsons et al. (2011) claimed that there is insufficient evidence of the effectiveness of one therapeutic intervention over others. As the learner's therapeutic needs affects their educational needs and vice versa, the investigation now discusses the use of educational interventions in schools.

2.4 Educational Interventions

Practitioners are skilled in understanding what the learner needs to learn and have adopted an effective and meaningful range of educational play based strategies to meet each learner's needs. Macaskill, (2005) and Shane et al. (2011) have argued that language and communication skills develop from the use of eye contact, facial expression, gestures, social proximity, conversation and turn-taking. Developing language and communication skills, therefore, cannot be met through isolated contributory attempts by practitioners, but through daily motivation and encouragement in a whole school and educational approach (Jones, 2013).

To address learners' needs, practitioners collaborate with appropriate multidisciplinary teams taking into consideration each learner's variance and spectrum of needs (Table 2.2:14) in relation to the effects on the learning (Kemp, 2010b). The evaluations recommendations and implementation of appropriate interventions have resulted in the compilation of the Individual Educational Plan (IEP) and each learner's appropriate curriculum (Sanches-Ferreira et al. 2013). The IEP is compiled by the school staff, which builds on the curriculum and documents specific targets, actions and strategies and how they will meet the individual's needs. Sanches-Ferreira et al's (2013) studies have highlighted that some IEPs were devised from poorly written documentation, measurability issues, which were not appropriately addressing individuals' needs (Silveira-Maria, 2013). This could result in influencing some of the learners' progression in their curriculum.

The Curriculum

Some researchers (Garner et al. and Hornby, 2012) viewed the National Curriculum as being problematical and disastrous for some learners due to the curriculum's emphasis being on communication, discussion for problem solving and dissemination. Practitioners find the National Curriculum difficult to understand or interpret for learners with ASD due to these learners' spectrum of needs (Jones et al. 2009).

The researcher agrees with Farrell, (2010) and Hornby, (2012) that some learners have difficulties achieving the National Curriculum levels and only manage to achieve working towards level 1. This sometimes results in their unintentional exclusion or modification to a broad balanced visual structured educational curriculum (Farrell 2010; Hornby, 2012).

Mesibov and Howley, (2003) and Farrell, (2010) endorsed this quote from QCA (2005a-5c) and DfEE (1999) 30-inclusion statement emphasising that:

> an entitlement to learning must be an entitlement for all learners and schools to provide effective learning opportunities for all learners…
>
> (DfEE, 1999:184)

Several schools use 'P' Levels or the Elaborated 5-14 Curriculum (The Scottish Government, 2006; Farrell, 2010; Calvert and Gardan, 2006) to assess learners who find the National Curriculum too demanding (The National Curriculum, 2005a, 2005b; Riddick, 2009; Fisher, 2011a, 2011b; Pope 2011; Garner et al. 2012).

It has been found (Kluth, 2003; LaBarbera and Soto-Hinan, 2011) that some learners in mainstream education are:

> excluded from rich and meaningful literacy experience such as reading and writing stories, joining book clubs, acting and performing and participating in whole-class and small-group discussions.
>
> (LaBarbera and Soto-Hinan, 2011: 6)

The researcher considers the reason for exclusion from a literacy experience could be due to practitioners' uncertainty of the resources and provision needed for these learners or a misunderstanding of each learner's learning capabilities. It has been argued (Kluth, 2003; Roskos et al. 2009) that speech on its own; has been considered as one of the easiest ways to promote language learning for example, the teacher reading out in the class.

Nevertheless, the researcher's understanding is that there is sometimes an oversight by teaching staff who think that some learners do not have a reading ability and wrongly categorise them as non-readers, (even practitioners in special schools). Thereby, not allowing learners the opportunity or give them encouragement through diverse ways, to participate fully in rich meaningful literacy experiences (Roberts, 2011). Research has indicated that some subjects in the school curriculum are perceived as being of greater importance but need language and communication skills to study them.

Some learners' vocabulary, reading and mathematics skills have shown to have developed using each learner's interests. This has been by using a thematic approach, by cutting out pictures from newspapers and magazines and incorporating them into personalised reading and math's books (Roberts et al. 2011). The use of their interests would give the learner's their own meaningful individualised curriculum (Tzanakaki et al. 2014), which could be adopted for this investigation. Although traditional methods have improved the communication skills and the language development of some learners, others have made advancements in group and/or class situations or in a naturalistic setting.

Therefore, computers have now become part of today's society. The literature review (Baxter et al. and Jordan, 2013) acknowledges that a combination of low and high-tech Alternative Augmentative Communication (AAC) systems need to be used for learners to understand and be understood by others.

2.5 High-tech Alternative Augmentative Communication (AAC) systems (Hardware)

High-tech AAC systems are electronic, computerised aids and computers. Some learners benefited from using a Voice Output Communication Aid (VOCA) for their difficulty in articulating. Conversely, the effectiveness of this therapy has been questioned (American Speech-Language-Hearing Association, 2006) as to whether the use of simple pre-stored non-interactive routine phrases with their slow speech output could restrict the flow of conversation, with some learners finding the devices difficult to operate (Hawley et al. 2013).

Furthermore, it was not clear as to whether the variance of each learner's autistic, therapeutic and educational needs (Table 2.2:14) had be taken into consideration before implementing the use of VOCA in studies.

The literature review findings of (Boucher, 2008; Parsons et al. 2011:47-63) identify disadvantages and fears of the use of computers (Table 2.4:22).

Table 2.4 The disadvantages of computers for learners with speech, language and communication disorder (Parsons et al. 2011:47-63**).**

Disadvantages
New unproven software used.
An overestimation of the choice of aids results in it not being unused.
Speed of communication through a communication system is said to be slow.
Interactive conversation becomes ineffective and breaks down due to lack of understanding, by a person unfamiliar with each learner's communication aid.
High tech AAC systems considered to be cold, non-vibrant, non-creative
The computer-generated robotic speech has pronunciation and intonation, which is not as clear as human speech.
Software could dominate the learners' interest to the extent of 'exacerbating' their autistic difficulties such as their ritualistic, obsessive and repetitive issues, isolating them.

Nevertheless, research findings (Boucher, 2008; Parsons et al. 2011) have also highlighted many therapeutic and educational advantages and effectiveness of high-tech AAC devices such as computers and computer software (Table 2.5:22).

Table 2.5 The advantages of computers for learners with speech, language and communication disorders (Parsons et al. 2011:47-63**)**

Advantages
Teaching reading
Influencing cognition
Easily controllable and highly stimulating visual and auditory environment
Accessibility for learners with fine motor skills
The correct hardware and software to help construct conversation
Helping increase vocabulary through their motivation and interest whilst playing with educational multimedia software.
Help practice their skills
Entertain them through a safe, fun medium and supportive environment
Contributing to each learner's therapeutic and educational development

Dsouza et al. (2012) showed these learners preferences for playing with computerised technologies. This investigation suggests that playing on computers have become part of a naturalistic classroom setting for educational and teaching purposes and its adaption in individual's curriculum (Parsons et al. 2011; Al-Elaimat, 2013).

The teacher's attitudes towards computer hardware has changed since the researcher's unpublished 1994 study as practitioners are now more knowledgeable and willing to be Information Technology (IT)-trained, since the National Curriculum stressed the importance of IT within the curriculum (Fisher, 2011a, 2011b; Pope, 2011). The investigation suggests that learners should, however, be given the correct computer hardware and appropriate software and matched to the variance of each individual learner's needs (Kemp, 2010b; Table 2.2:14).

2.6 Software

Information & Communication Technology (ICT)

The researcher's small-scale 1995 unpublished case study established that concept keyboards, touch screens and multimedia software were being used in primary schools in 1994. This study highlighted that computers were helping some disabled learners by easing their manual dexterity and frustration and gave them an outlet for their language development.

Interestingly, the qualitative findings from the researcher's 1995 study revealed that the Information Technology (IT) co-ordinator in a special school claimed that:

> IT has been seen in our school as a major source of support for some learners with various physical disabilities and special needs. It has enabled greater access to learning for many of our learners.

ICT is said to produce hidden abilities, which are normally said to be unachievable using conventional methods.

The qualitative findings from the researcher's 1995 small-scale study revealed that the Information Technology (IT) co-ordinator in a special school claimed that:

> Good software needs to be set up and continually changed according to each learner's needs.

ICT covers a range of tools and techniques relating to computer technology and is used across the curriculum and included in all subjects, as well as being its own subject (Fisher, 2011a, 2011b; Pope 2011).

ICT has been seen in schools as a major source of support for learners with various disabilities and learning needs, enabling greater access to learning for many of the learners (Jones et al. 2009; Shane et al. 2011). These researchers regarded computers as providing help with motor, speech, language and communication problems as well as being educationally beneficial for learners with ASD.

The ICT programs supporting wider school curricula activities demonstrated the usefulness of the software for achieving transferable skills into their educational learning (Karkhaneh et al. and Schneider and Goldstein, 2010).

Tseng and Do (2010:468) study concluded that 'there will be more and more ICT designed specifically for ASD children because ICT can truly complete the real life for children with ASD'.

It has been said, however, (Parsons et al. 2011) that an assessment for the potential use of ICT and software needs must be ascertained through data gathered by a multi-disciplinary assessment. The researcher is in agreement with Hughes's, (2005) theory that:

> it is better to know and understand each learner's needs, consider the range of ICT resources that are available, and match them.
>
> Hughes, (2005:269)

Hughes' theory will be adopted and adapted by this investigation through a collaborative (Frauenberger et al. 2012) holistic approach using the practitioner's knowledge of the diversity (Wing et al. 2012; Aspy and Grossman, 2014) of each learner's needs and interests. This will be through the design, development and evaluation (Sanches-Ferreira et al. 2013) of individualised multimedia software.

2.7 Multimedia

Software has improved from the overloaded 'drill-and-practice' programs to word recognition, word processing, data handling programs etc. Although, 'drills and skills' software is still in use, as it enables learners' to concentrate more on the creative aspects of writing, rather than perfecting the mechanical part of writing. This empowers learners with disabilities to excel with the use of computers and this was discussed in the researcher's 1995-1997 unpublished studies (Jones et al. 2009).

Furthermore, the researcher's 1995 unpublished small-scale case study demonstrated how a five-year-old physically disabled learner gained therapeutically and educationally when surrounded with language in an infant classroom in a special school, whilst interacting with word processing.

As word processing is text-based only, the investigation needed to discover if multimedia software with the inclusion of text, sounds, graphics and animation would be as or even more therapeutically and educationally beneficial.

The researcher, therefore agreed with others (Inclusive Technology, 2005; Rahman et al. 2011) that the vast range of software available were not matching each learner's needs.

Furthermore, Putnam and Chong, (2008) and Rahman et al. (2011) claimed that these anomalies and concerns could be rectified through a continuous collaboration with the practitioners, working as co-designers, developers and evaluators with software developers.

This could be achieved by matching the diversity of each learners educational and sensory needs to curriculum subjects for the development of therapeutic/educational multimedia software (Wing et al. 2012; Aspy and Grossman, 2014).

The researcher's multimedia technical knowledge had been gained from teaching and lecturing over many years and enabled her to ascertain that multimedia is an amalgamation of a combination of elements (text, sound, graphics, animation and video) (Cooper, 2013). These are used in multimedia software, together with, interactivity relating to the channels of communication e.g. printed words on the screen, speech or music, photographs, pictures and drawings animated in cause and effect programs (Charsky, 2010; de Urturi et al, 2011).

The researcher taught multimedia university students over many years giving students coursework without bringing society into academia. The researcher wanted to give the students transferable and employability skills demonstrating the importance of their studies to problematical areas in society. As the researcher agreed with Parsons et al. (2015) that children with ASD would benefit from evidence-based practice and knowledge co-creation technology, this investigation would, therefore, achieve this through on going collaboration (with design, development and evaluation) with practitioners and developers (university computing students) developing individualised software.

Individualised

Jones (2006:545) claimed that when developing software development teams should take into consideration 'key variables usually include the age of the child; their intellectual level; interest; language level; social understanding and whether parental involvement is required or desirable'.

If these are not known, staff ends up introducing an intervention to a whole class group resulting in some learners not benefiting from the intervention from their lack of stimulation and motivation (Macaskill, 2005).

The investigation suggests that software developers need to keep their focus on giving every learner an individualistic, stimulating and motivating opportunity and means for encouraging their language skills. This would be achieved by focusing on each learner's goals which practitioners were attempting to meet, to achieve each learner with ASD's full potential. Fletcher-Watson, (2014) concurred with this claiming the importance of matching the user's profiles, stipulating their needs and preferences, to technology.

Mejia-Figueroa and Jurarez-Ramirex's (2014, 2015) and Ju, (2016) studies carried out at the School of Chemical Science and Engineering at the Automous Univ of Beja California, Tijuana, Mexico highlighted the importance of using the user's characteristics when developing software for learners with ASD. They stated that this would be 'challenging…due to the…nature of affliction makes each person unique' (Ju, 2016:195). This investigation will determine this from the practitioners (users).

Putnam and Chong's (2008) study on software and technologies designed for people with autism used the results of online qualitative and quantitative data from parents, family members, special educational needs practitioners and other practitioners who worked with these learners. They claimed that there has been minimal research into the development of useful technologies with an aim being the learners' goals.

The researcher agrees with this and further claims that in would be important for the software development team to collaborate with practitioners to learn each learner's needs and goals and then develop the software with the practitioner's involvement in the process. This should result in developers and practitioners being co-designers and developers. Practitioners evaluating the software before implementation and monitoring, recording and testing out the software with the learner to establish its therapeutic/educational benefit/value for their learners.

Parsons et al. (2011:97) further added that 'a range of educational provision should be maintained' to cater appropriately for a wide diversity of needs.

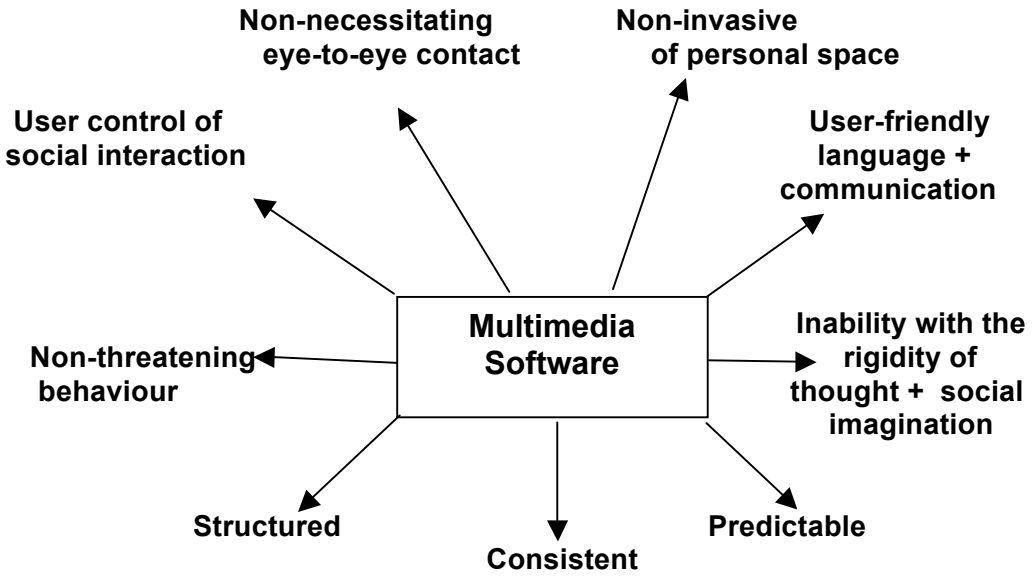
Wainer and Ingersoli (2011:99) claimed that there was still a limitation of empirical research and support due to the development of intervention for these complex learners. They emphasised that to validate the benefit/value of computerised interventions for these learners, future investigations must demonstrate their 'efficiencies, effectiveness and validity across large diverse samples' of individuals with ASD'. The researcher agrees with this however this needs to be established from the practitioners. The researcher wanted to amalgamate these areas and bring society into academia with on-going cohorts of university computing students developing individualised multimedia games for real learners with ASD in society, as part of their studies. This had not been achieved by researchers/developers in past studies (Wing et al. 2012; Aspy and Grossman, 2014; Table 2.11:62).

Furthermore, the study has established that learners with ASD have demonstrated a preference and relate well using computerised technologies and multimedia software. The investigation proposes that this may be due to the empathy some of these learners have with software due to similarities software have with these learners.

Usefulness of specific software with these learners

The researcher suggests multimedia software does not give eye-to-eye contact, which some of these learners do not like giving (Shane et al. 2011 Fig. 2.2:29). Software does not invade personal space for learners who have difficulties with the proximity of others. The language and communication of software can be developed to be learner friendly, whereas, language from people can be varied. Both software and learners have an inability to take into consideration the rigidity of thought and social imagination of others and work from a structure, consistent, predictable, rigid and stable process which these learners need (Frauenberger, 2015; Fig. 2.2:29).

Fig. 2.2 The similarities with use of multimedia software and learners with ASD.



Researchers (Volkert and Vaz, 2010; Heimann and Tjus, 2011a, 2011b) have indicated the essential importance of structure and consistency along with the appropriate levels of stimulation, which needs to be taken into consideration by software developers, as these learners need consistency, structure, predictability and routine. This can be achieved through collaboration with practitioners using their expertise and knowledge on the diversity of each learner for the innovative development of computer technology (Davis et al. 2007; Wing et al. 2012; Aspy and Grossman, 2014).

Software can be developed to demonstrate non-threatening behaviour, whereas learners could face what they might consider threatening behaviour in the community. This could enable learners to socially interact, on their terms, by allowing the learner to use their preferential modalities (tactile, visual and auditory) and elements (text, sound and animation) (Fig. 2.2:29).

Senses

Smells, visuals, sounds, transition, interacting with people, proximity of others (Shane et al. 2011; VanBergeijk et al. 2012), failure to communicate ideas and feelings, inability to read, not understanding nonverbal clues and how others think and feel may result in behavioural difficulties (NAS 2010a; Lanou et al. 2012).

For example, a learner trained by one person to make a specific statement in response to a picture or object may not respond in the same way when looking at the identical picture or object with someone else. This may be due to the learner's difficulty with their senses, e.g. another persons' smell, the tonality of the persons' voice, their visual appearance, etc. Using computer software, however, could help alleviate the inconsistency of human interaction (Wainer and Ingersoli, 2011; Table 2.6:30).

Table 2.6 Possible reasons for inconsistency of language through inconsistency of human interaction

Difficulties with:
Approaches and strategies
Lack of empathy
Tonality of voices
Behavioural approaches
Smells, look, feel and tastes of different people
Rapport with different people
Understanding of their capabilities, strengths, likes, interests
Communication skills
Understanding of their spectrum of needs
Language and educational environments and surrounding
Understanding of predictability, structure and consistency

2.8 Modality and Elements

Furthermore, the researcher's computing concepts have emerged through years of teaching and have established that a computer is an all-round interactive communication tool. An example of this can be from hearing sound from the speakers, see the animated graphics and printed words on the screen and touch the screen, switches, mouse or keyboard, enabling the learner to become manually and physically interactive).

This investigation suggests that language and communication may be achieved using computers to stimulate and motivate learners' tactile, visual and auditory modalities (Kemp, 2010b; Bogdashina, 2011). This would give learners language and communication channels, through the elements of multimedia e.g. printed word in the form of text, moving pictures in the form of graphics and animation and narration and music in the form of sound (Satterfiled, 2013).

Studies were not stating whether the practitioners had input in the design and development and evaluate the product claiming its therapeutic/educational benefits. This will be adopted for this investigation through meeting the objectives (Table 2.12:63) to answer the research questions (Table 2.13:63).

Modality in relation to multimedia software comprises of the learner's tactile, auditory, and visual interaction with the software. The elements of multimedia software are text, sound, animation, graphics and video. The combination and preferences of the modalities, elements and channels of communication could give some autistic visual learners an interactive, stimulating and motivating opportunity for learning (Frauenberger et al. 2012; Kamaruzaman et al. 2016). Wainer and Ingersoli, (2011) continue by claiming the importance for developers to focus on ways of stimulating and motivating learners. This would be achieved using visual and auditory stimuli to ensure that the learners get enjoyment and are motivated by playing the software resulting in the learners being engaged in their learning. They suggested that future studies using computers with learners with ASD should establish 'high program satisfaction and positive child gains'. Unfortunately, Kemp (2010b) and Bogdashina, (2011) claimed that the sensory problems of some learners are often overlooked. Furthermore, Kemp (2010b) claimed that learners show a preference for using multimedia interventions with visual and auditory reinforcement, allowing their independent control through tactile choices.

Text and Tactile

The researcher's professional technical knowledge and experiences as a multimedia practitioner suggests that multimedia software could be considered as a stimulating and motivating visual, auditory and/or tactile, interactive therapeutic/educational classroom intervention. This is due to text (the written and printed word) used by practitioners in classrooms, being a static and linear form of communication channel (Berk, 2011). Whereas, the use of multimedia software, could be regarded as a solitary passive 1:1 (computer/learner) interaction, which may appeal to some of these learners.

Nevertheless, some learners have tactile difficulties due to their sensitivity and resistance to proximity (Shane et al., 2011; VanBergeijk et al. 2012) and may have difficulties using the computer.

The non-linear and interactive use of text in the software could, however, stimulate and motivate these learners by making the static and linear text more visually appealing with animation and sound giving the printed word a voice (Table 2.7:32). The researcher's 1995 unpublished study demonstrated how non-personalised overlays puzzled a learner with unfamiliar words, such as 'kipper', which he did not seem to understand.

Table 2.7 Enhancing text within multimedia (Berk, 2011: 24)

Text in multimedia software gives learners:
Compliments, rewards and feedback
Clear on-screen written instructions
Positive encouragement and reassurance
Static and live words, sentences and stories
Fun activities and rhymes
Text on buttons to help navigational control
Hypertext links
Animated text
Functional use of written language

In relation to text, the investigation suggests that if learners have difficulties with reading and comprehending text in the software they could be given auditory information with written text. Individualised therapeutic/educational computer software could help their speech, language and communication plus their educational needs.

Sound and the Auditory learner

The researcher suggests that learners could be given the opportunity to listen to difficult targeted sounds and words and click on an animated computer images.

This could aid their speech and language development as well as the educational benefits of the software and could be used alongside conventional speech and language therapy and educational classroom strategies.

The investigation needs to establish the learner's with ASD preferences for modalities and elements (Berk, 2011; Bogdashina, 2011).

The literature review highlighted (Kemp, 2010b) that learners are attracted to the visuals and sounds from computers. Whereas, some learners have difficulties with hearing and comprehending voices, sounds and speech (Shopler and Mesibov, 2010; Wing, 2010a). From the researcher's understanding sounds can be very disturbing due to some learners' sound sensitivity and hyper acuity, whereas, others could be less auditory sensitive and may be attracted to sound and visual stimuli. This would be very important information to ascertain before the development and use of individualised therapeutic software for these learners. Interestingly, the voice of the computer has been criticised as being robotic but various researchers (Checkley et al. 2010) have claimed that some learners prefer this consistent artificial vocalisation, tonality, amplitude and frequency, rather than the human voice (Wainer and Ingersoli, 2011). Nevertheless, there are many advantages to the sound in multimedia software (Table 2.8:33) such as text being, read aloud to non-reading learners and the narration in computer software helping some non-reading visual learners therapeutically and educationally through their auditory modality. Unfortunately, Sharmin et al. (2011) and Frauenberger et al. (2012) claimed that there was relatively limited availability of software, which had been evaluated for their therapeutic and educational use by practitioners.

Table 2.8 The advantages of sound in multimedia (Kemp 2010b:15; Berk, 2011)

Sound in multimedia software gives learners:
Compliments and rewards through vocal and tuneful feedback
Sound effects to aid comprehension
Auditory positive vocal encouragement and reassurance
A helpful reader and narration of stories
Melodious and musical fun activities and rhymes
Verbal encouragement to imitate sounds and words
Verbal encouragement to promote speech, language, conversation and communication
Vocal instructions to encourage interactions and navigation control
Functional and non-functional use of language

Through on going collaboration with practitioners, each learner's auditory needs would be taken into consideration by this investigation. This will result in verbal positive feedback, prompts and instructions given through audio output in individualised software, in the hope to give verbal encouragement and guidance.

This will be reinforced by practitioner's verbalisation. Furthermore, Jones et al. (2009) and Krippel et al. (2010) stressed that computers had a good visual and auditory appeal for some learners and further suggested that those with auditory modality difficulties could be given information through their other senses, i.e. graphically.

Graphics and the visual learner

Research has shown that computers have had a good impact educationally for autistic learners in special schools as a visual medium. Grandin, (1996, 2011) an adult with ASD, claimed that:

> thinking language and words is alien to me. I think totally in pictures. It is like playing different tapes in a videocassette recorder in my imagination.
>
> Grandin (2011:3)

The literature review (Berk, 2011; Geneva Centre for Autism, 2011) together with researcher's professional and technical knowledge, as a multimedia practitioner, has resulted in this investigation suggesting that graphics and animation could make written and printed text come alive.

This would be through interactively stimulating and adding humour to a serious world, using an exciting, visual, on-screen language which could be a fun way for some visual learners to communicate (Table 2.9:35).

This investigation suggests that graphics could help some visual learners learn language through movement, thereby reinforcing learning through their visual modality.

Table 2.9 Advantages of using graphics and animation in multimedia (Berk, 2011: 24; Parsons, et al. 2011:47)

Graphics and animation in multimedia software.
Graphical and animated feedback
Visual and animated rewards
Graphical animated concepts, which are difficult to comprehend
Visual and animated positive encouragement and reassurance
Interactively and enthusiastically encouragement of reading and storytelling
Making activities fun
A dynamic and pleasurable way to encourage interactive speech, language, conversation and communication
A pleasurable way to give instructions
An exciting way to encourage interactive navigational control

It has been said (Geneva Centre for Autism, 2011:1) that 'a picture is worth a thousand words' and as some learners with ASD are said to be visual learners with visual skills, to help them develop language it is important to provide them with pictorial information whenever possible.

Researchers (Macaskill, 2005; Lal, 2010) have claimed learners with ASD with language difficulties benefit from using their visual modality with visuals, graphics and symbols.

This enables them to learn by recognition, helping them to imitate communication and organise, sequence, and understand tasks through visual representation. Games such as matching identical pictures could be adopted and adapted in the development of individualised computer software and be evaluated by practitioners as being of help to promote and stimulate speech, language and communication (Frauenberger et al. 2012). The investigation suggests that when choosing visual images it may be worth considering the learner's visual appreciation to get their participation. Allowances need to be made for learner's preference or negative reaction to specific colours, images and sounds.

These learners need to be given information through their appropriate senses. This investigation explored the therapeutic/educational benefits/value use of video (Kemp, 2010b).

Video within multimedia

The literature review (Berk, 2011; Geneva Centre for Autism, 2011) together with the researcher's professional and technical knowledge would suggest that video incorporated into multimedia software could help therapeutically and educationally. Video would give learners a safe glimpse into a sometimes unnervy, sometimes frightening, unknown, changing world, bringing realism to these learners through a safe virtual environment or activity. This could, in turn help stimulated and motivated these visual, auditory and/or tactile learner's triad of impairments (Lanou et al. 2012; Yates and Courteur, 2013).

Video can equally be considered as a passive communication channel with the learner sitting and watching without becoming involved. There are advantages for video in multimedia software (Table 2.10:36). They can be a visually, aurally useful effective intervention for language and learning (Berk, 2011; Parsons, et al. 2011).

This investigation has established that pupils with ASD were visual, auditory and/or tactile learners who had a diversity of therapeutic and/or educational needs.

Table 2.10 Advantage of video in multimedia software (Berk, 2011:24)

Video could give learners:
Glimpse into a virtual world
A sense of realism
Rewards and feedback
Help in transferable skills
A way of complementing verbal language through sign language
A safe way of communicating issues for example danger
Help through training, skills
A sense of the unknown
Help with Social imagination
Compliments and rewards through vocal and tuneful feedback
Sound effects within video to aid comprehension
Auditory positive vocal encouragement and reassurance within video
Tunefully and musical fun activities and rhymes within video
Verbal encouragement to imitate sounds interact with speech, language, conversation and communication and words within video

They had modality and multimedia elements preferences (Berk, 2011) and enjoyed playing computer software (Munson and Pasqual, 2012; Heimann and Tjus, 2011b). The combination of multimedia elements and interactivity relating to autistic learner's modalities may give learners a perspective of realism, motion and a glimpse of feelings or complexity, which written and printed words cannot quite fulfil.

Kemp, (2010a) and Bogdashina, (2011) also acknowledge that learners need to be given information in an interactive environment through their appropriate visual, auditory and/or tactile modalities to help them communicate.

This literature review has identified (NIDCD, 2003; Walbam, 2014) that some learners are overwhelmed, while others are under-stimulated by the same sensory stimulation.

The practitioners working in collaboration with software developers could indicate each learner's sensory needs and evaluate each individualised game developed as to whether it would meet the sensory needs of each learner. This investigation suggests that each learner's sensory needs and skills should be highlighted by practitioners and taken into consideration by software developers to lesson behavioural difficulties.

Collaboration/Design/Development/Evaluation

In view of the diversity of these learners needs, research findings were not demonstrating the collaboration of practitioners in the design and development of the software (Frauenberger et al. 2012). There are also no research studies indicating that practitioners had implemented, tested and evaluated the therapeutic/educational benefits/value of individualised multimedia software on large cohorts of learners with ASD. Furthermore, this was not shown to be on an iterative basis, over a period and in different educational establishments (Sanches-Ferreira et al. 2013). These areas will be taken into consideration through ensuring that the objectives (Table 2.12:63) have been met and to answer the research question/s (Table 2.13:63).

Fletcher-Watson, (2014) claimed that there is currently no systematic comparison of technologies developed with or without expert consultation input, pilot testing, using a design and redesign process to ascertain the efficacy, motivation and learning of the final product.

This investigation, however, will be using a systematic collaborative approach with the practitioners. The developers will have a continuous involvement in the design and development. Practitioner's will provide feedback, reflection, modification and evaluation as to the therapeutic/educational benefit/value of individualised software.

Ehn and Kyng (1991) claimed that Scandinavian researchers highlighted the effectiveness of software developers and 'workers' working in the collaboration with the design and development of language games. Furthermore, many other researchers (Breidegard; Eftring; Enquist; Mandre; Svensk, 2006; Spinuzzi, 2002, 2005) concur with Ehn and Kyng as to the benefits of working in collaboration with individual users on designing software for them. The Scandinavian studies highlighted that the learners' perspective, needs, preferences, etc. needed to be taken into consideration through the learner's input. However, some learners with ASD are unable to communicate their needs, preferences, likes and dislikes. This investigation, therefore, suggests that researchers and developers need to work in collaboration with the practitioners (users) in the design and development of individualised software. Practitioners can impart their expertise and knowledge about each learner (end-user) with ASD. They would also evaluate the therapeutic/educational benefits/value of the software, as they would be implementing the appropriate software in the classrooms.

Comprehension software

Davis et al.'s (2007) study with six learners (five boys, one girl, ages 7-9) with moderate learning difficulties (MLD) and a diagnosis of autism reflected on the design of feedback and opportunities in software for promoting understanding of narrative for learners with autism. This gave them some insight into learners' goals and understanding.

Davis et al. acknowledged the diversity of their learner's needs whilst highlighting commonalities. Nevertheless, they did not take into consideration the vast variance of each of these learners' particular therapeutic/educational needs, likes and interests using generic software (Kemp, 2010a). Their study using software to promote understanding about narrative was however only effective for six learners. It would be more note-worthy had the study used a larger group of participants and a collaborative holistic approach through an on-going process.

Self-help, social skills, social interaction and social stories software

Past studies (Hetzroni and Tannous, 2004) study used five learners, age range 7.8-12.5. Three were male and two were female. These learners had a formal diagnosis of autism with normal hearing, vision, and mobility plus functional communication/delayed echolalia, irrelevant speech, intentional communication (verbal initiation).

The researchers and a computer programmer developed the software with three different settings showing daily activities (play, food and hygiene). Animation and familiar phrases had been incorporated giving the learners choices. The researchers claimed the learners had the opportunity for vocal communication, non-verbal and verbal expression. Their study showed less than 50% use of functional speech, an increase of vocabulary and relevant speech and sounds, a reduction of their echolalic language and behavioural difficulties and an improvement in their communication skills. They further claimed that the learners were more attentive, stimulated and motivated, gained transferable skills and improved their academic skills. Hetzroni and Tannous did not demonstrate whether the researchers and computer programmer had collaborated with practitioners in the design, development and evaluation of the software and tested with large groups of learners over an extended period of time.

This investigation will have established the diversity of these learner's therapeutic needs and interests. This will be adopted through a holistic approach, taking into consideration, from practitioners, transferable concepts being taught in the classroom.

Sanches-Ferreira, et al. (2010) and Richardson's (2015) research have demonstrated that there is evidence as to effective use of social skills technology to train children with ASD. Richardson's research did not highlight if the diversity of these learner's social skills had been adopted for the social skills software used. This investigation will endeavour to incorporate the variance of each learner's social skills needs into individualised software (if the practitioners regarded this as being of importance). Practitioners will test and evaluate the individualised social skills software and confirm its therapeutic/educational benefits/value.

Li, et al.'s (2013) research used computer-based social stories storybuilder software for children with autism. The software was developed using situations and concepts that they considered meaningful for autistic learners.

Although these researchers claimed that this was effective, however, they did not indicate if the software had been tailor-made for each learner in collaboration with practitioners. It did not demonstrate whether practitioners tested and evaluated (Frauenberger et al. 2012) the software as being therapeutically/educationally beneficial to their individuals. If practitioners regarded that social stories should be incorporated into software, the investigation will endeavour to include this in the design and development of individualised therapeutic/educational software.

Therapeutic software

Some researchers (Wainer and Ingersoll, 2011) have claimed that there have been only a few studies with a limited amount of software demonstrating effective use in the classroom for learners' language development and skills. This maybe because staff were unaware of what was appropriately available for use with language development and their lack of time and skills to explore and experiment with unknown software.

The investigation suggests that it may be difficult for practitioners to change and find new exciting ways of using multimedia software for autistic learners' language development.

It appears that practitioners seemed to be content with the familiarity of their existing software, have time limitations and a lack of knowledge on the availability of the software, which would be appropriate for each of their learners. The investigation focuses on how this could be rectified through developers collaborating with practitioners (Frauenberger et al. 2012) enabling them to be involved in the design and evaluation of the software developed for them and by addressing each of their learners therapeutic (language skills) needs (Table 2.11:62). This would be achieved by this study meeting the objectives (Table 2.12:63) in order to answer the research questions (Table 2.13:63).

Whalen and Liden et al. (2006) developed 'The Teach-Town' software with eight preschool children and followed up this study in 2010 with a randomised group of 47 children. Researchers (Berk, 2011; Wing et al 2012; Aspy and Grossman, 2014) have claimed that the computer game 'Teach-Town' was effective for the learners with ASD. Although, their investigation highlighted the diversity of these learner's language skills, their study had not demonstrated what the variance of each learner's language skills had been and how they adopted this for the development of their software. Researchers (Frauenberger et al. 2012; Sanches-Ferreira et al. 2013) were claiming the importance of practitioner's collaboration and evaluation of products. There did not seem to be any evidence, however, that the 'Teach Town' software had been developed in collaboration with practitioners with them evaluating its therapeutic benefits for their learners. This will be rectified and adopted by this investigation through meeting the objectives (Table 2.12:63 by adopting a Design-For-One approach for this investigation to answer the research question/s (Table 2.13:63).

Rahman et al. (2011) believe that there are very few software programs, which have been evaluated as being of use and effective for some learners with ASD's speech difficulties. This study, however, will rectify this with practitioners working in collaboration on the development of the software and are able to evaluate (Frauenberger et al. 2012) the software's therapeutic use for speech development before its implementation in the classroom.

Nevertheless, Heimann and Tjus (2011a and 2011b) claimed that drill and practice software, which was being developed, involved the production of targeted utterances, upon command and/or in response to a specific picture or collection of objects (Law et al. 2012). It did not necessarily, however, lead to spontaneous use of trained utterances. Whereas, if, the specific picture or collection of objects had been tailored to the interests of the learner this might have encouraged the learners with speech difficulties to use vocal and/or verbal communicative language.

Munson and Pasqual, (2012) concurred with Tunmarsh/Tollgate Speech Recognition Research Centre (2005) studies as to the possibilities and advantages of using multimedia in therapeutic and educational innovative ways for helping each learner's language and conversation through a stimulating interactive language and conversational educational environment.

Islam et al.'s 2013 study claimed the effectiveness of speech development through the software identifying the sounds made by the eight children in relation to items in an interactive game. Their small study did not state how the children were chosen or each child's diversity of autistic and therapeutic and needs, computer capabilities and modality preferences. Their paper also did not demonstrate how the tests were carried out. It did not state how the software was developed in collaboration with practitioners using their expertise together with the children's use of gestures, speech, sign and body language (Ganz et al. 2012), strengths, weaknesses, likes, dislikes and interests. The study had not stated whether the software had been evaluated by the practitioners on an iterative basis over an extended period of time. This investigation will rectify this through the collaboration of practitioners to ascertain whether the software developed by this investigation would instigate speech, language, communication, non-communicative sounds, signs, gestures etc. to confirm the therapeutic benefit/value of the software.

Recent studies (Kamuruzaman et al. 2016:889) have claimed that with the 'appropriate [therapeutic/educational] software' children with ASD who have severe speech impairments would be helped to communicate.

Educational software

Heimann and Tjus, (2011a, 2011b) highlighted that some learners were able to understand the meaning of language and may be taught to read with the use of text, phonics and sounding out the letters correlating with interesting and relevant pictures embedded in software. This, thereby, demonstrates being effective for reading and language skills.

They did not however indicate the diversity of these learner's educational (literacy and numeracy) needs and their modality and element preferences, which this investigation will be adopting through a holistic approach for the development of individualised software.

Light and McNaughton (2012) stressed the importance for there to be resources, which help children with complex communication, language and literacy needs.

King et al. 2016 have claimed that this has been achieved with maths software for children with ASD. The investigation concurs with this as it has demonstrated there is a diversity of each learner's language and communication (therapeutic) and literacy and numeracy (educational) needs. These would be taken into consideration in the development of individualised software and will be met by the objectives (Table 2.12:63) to answer the research questions (Table 2.13:63) and meet the aims of the investigation.

Nevertheless, Tzanakaki et al. (2014) studies highlighted the importance of providing children with ASD with an individualised curriculum for teaching numeracy skills. This investigation further suggests the importance for ascertaining the diversity of each learners' numeracy skills for the development of individualised software.

Computer Aided Instruction (CAI)

Heimann and Tjus, (2011a; 2011b) studies used a Computer Aided Instruction (CAI) program with eleven learners with autism, six with dyslexia, four with hearing impairments and two with cerebral palsy. Their studies encouraged the learners to construct sentences using the software and in turn receive feedback from sound/graphics/video. It demonstrated the use and effectiveness of multimedia software with the inclusion of sign language for literacy, reading, teaching communication and social skills, to give learners communicative learning opportunities.

Their research demonstrated that some learners were responsive to multimedia software and showed some improvement in their verbal and social interaction with their teacher. This also verified an increase in reading skills during the intervention period and positive effects on their phonological, verbal and social development.

Heimann and Tjus, (2011a; 2011b studies were only carried out with 11 learners with ASD and they had not indicated that they had taken into consideration the diversity of these learners therapeutic (variance use of signs, symbols and schedules) and educational (range of literacy and numeracy) needs, preferences, capabilities and interests. Furthermore, Heimann and Tjus studies were not claiming whether the software had been tested and evaluated by the practitioners on an iterative basis, on large groups of end-users, with practitioners themselves evaluating the software as being of therapeutic/educational benefits/value. This investigation will endeavour to achieve this with practitioners on going input in the design, development and evaluation of individualised software.

Fletcher-Watson, (2014) carried out a review of published evidence over more than four decades of research as to the value of Computer-Assisted Learning (CAL) for learners with ASD and the best practice in design, implementation and evaluation. Their research highlighted the importance of establishing positive evidence of the ‘efficacy’ of products and the best practice being carried out in research.

Fletcher-Watson claimed that there is:

> excellence in collaboration, interdisciplinary research where computer programmers work with psychologists, teachers, parents and others to create bespoke technology, but this element is rarely share in published findings', [with] 'a minority of projects providing any detail at all on the design process…'.
>
> (Fletcher-Watson, 2014:187)

Ploog et al. (2013) researched the use of Computer-Assisted Technology (CAT) to enhance children with ASD's social, communication and language. Eftring (2006) claimed that the use of computerised assistive technologies does not 'create social isolation' for learners.

In order to help children who have difficulties with understanding facial expressions, however, Baron-Cohen, et al's. (2007) study with 25 high-functioning autism aged 4-7 year olds with interests in computers and trains used software entitled 'The Transporters'.

Emotion Recognition software

The 'Transporters' software was used over four week periods, for 20 minutes a day. The software gave the train's animated facial expressions and was effective for these children. This study did not indicate whether the diversity of each learner's comprehension had been taken into consideration with the practitioner's involvement in the design and development of the software. Golan et al. (2010) study further investigated the enhancement of children with Autistic Spectrum Condition's (ASC) emotion recognition with the use of animated vehicles and real emotional faces in the 'Transporters' software. This study evaluated the effects of eighteen 4-7-year-old children (high functioning, age appropriate, language and cognitive abilities and low functioning children with significant learning difficulties) with ASD.

The children watched the Transporter DVD for 15 minutes every day for 4 weeks. The DVD has key emotions of grafted real-life faces of actors showing different emotions enabling social interaction between toy vehicles. The researchers were claiming that the software was effective for all the children who participated in this investigation. The study, however, did not state whether the practitioners were involved in the design, development and evaluation of the product. Both Baron-Cohen (2007) and Golan et al's. (2010) studies were not demonstrating if the software had been tested with the same learners and others on an iterative basis and evaluated by practitioners as to the therapeutic/educational effectiveness of the software.

Nevertheless, as many children with ASD have an interest in Thomas-the-Tank Engine, it would be interesting for the 'Transporters' studies to ascertain through collaboration with practitioners the learners who have an interest in Thomas-the-Tank Engine. They could gain copyright clearance for the use of the Thomas-the-Tank Engine images. The faces of the Thomas-the-Tank Engine trains could be incorporated and animated in a computer game together with each child's name (in text and sound). This personalised, individualised software, with the use of their interests, could help them understand emotion recognition and further be of therapeutic and educational benefit/value in classrooms. This could also be tried with images of the learner's own face and even faces of their carers/teaching staff, incorporated in their own individualised software and animated to help the learner imitate and understand emotion.

Kouo and Egel (2016) study was based on research carried out from 2010-2016 on the efficacy of discrete trial training and videos, FaceSay, MindReading, The Transporters and MiX software. These researchers have highlighted that these studies were in relation of emotion recognition, which is 'critical' in the development of learners with ASD's social communication and interaction. If these are crucial in aiding individual learner's therapeutic/educational benefit/value these will be established through an on-going collaboration with the practitioners to meet the objectives and answer the research questions.

Furthermore, the researcher recently discovered that new technologies (electronic interactive whiteboards, robots, smart phones, tablets) were starting to be used in classrooms with learners with ASD. Studies in relation to Electronic Interactive Whiteboards (EIW) were showing some positive effectiveness for these learners (Yakubova and Taber-Doughty, 2013).

2.9 New Technologies

Electronic Interactive Whiteboards (EIW)

Yakubova and Taber-Doughty recent study used EIW with two learners with autism and one learner with moderate disability. They were taught to operate and view video modelling clips, perform a chain of tasks and self-monitor effects. This demonstrated effectively how these learners improved their acquisition skills using this self-operated and interactive device.

Parsons et al., Wainer and Ingersoli, (2011) and Yakubova and Taber-Doughty, (2013), however, claimed that studies to date merely used a very small sample study over a short period. The only participants' details taken into consideration were their age, gender, where they were on the spectrum e.g. mild/moderate and their IQ scores.

Yakubova and Taber-Doughty study did not demonstrate whether they had input from the practitioners and whether they had established the diversity of the learners with ASD's autistic, therapeutic and educational needs, (Wing et al. 2012; Aspy and Grossman, 2014; Table 2.11:62). Furthermore, their studies had not indicated whether the learner's impairments, mobility and element preferences, (Berk, 2011) capabilities, likes/dislikes, strengths/weaknesses and interests were also taken into consideration. The study had not been repeated on an on-going basis with the same and/or further large groups of participants in collaboration with practitioners. This will be rectified with this study through meeting the objectives (Table 2.12:63) in order to answer the research questions (Table 2.13:63).

Dautenhahn et al. (2009), Robins et al., Johnson and Gattegno, (2010) and Wainer and Ingersoli, (2011) go further, in demonstrating that some children have difficulties understanding facial expression and play better with robots such as 'Kasper' a robot boy (with minimal facial expression who can imitate a child's body movements) than they do with humans.

Robotics

Playing better with robots has been corroborated by Miller and Bugnariu (2016) claiming that learners with ASD respond better to digital media than to humans.

Gillespie-Lynch et al. (2015:35) claimed that although some learners were showing an interest in eliciting collaborative play by being more 'attentive to humanoid robots than toys or humans.' More attention may not translate to being of benefit/value for their therapeutic and educational needs.

Furthermore, Iovanone et al. (2003) and Wainer and Ingersoli (2011) have claimed that it is crucial that the learner's skills are targeted to enable the software intervention to give individualised support.

The researcher agrees with Fletcher-Watson (2014:95) that the development of individualised therapeutic/educational software for learners with ASD would be cost effective as compared to them having '1:1' learning support, expert therapist time, high quality parent training'. It acknowledges the strategies, resources, and support already being successfully used and suggests that individualised software could also be used as an aid for practitioners supporting learners with ASD.

Gillespie-Lynch et al. (2015) also claimed that the six children with ASD in the study showed more collaborative play with the human present. Wainer et al. (2014) further argued that this may be due to the children's familiarity with 'Kasper' before they played with a human.

Children, however, with physical, fine and gross motor problems would have difficulties depressing buttons to communicate with 'Kasper', as the robot was unable to understand speech. The studies, furthermore, did not reveal if 'Kasper' was effective for the learners who used sign and body language, gestures, symbols to communicate. It has not indicated if practitioners have evaluated 'Kasper' as being of therapeutic/educational benefit for these learners. Unfortunately, it would be expensive to develop many 'Kaspers' in order to trial it with large groups of participants in many schools.

Furthermore, it would be interesting to see if 'Kasper' could be incorporated into individualised multimedia computer game (or a gaming .app) for therapeutic/educational use in classrooms in many schools) with practitioners recording and monitoring the benefits/value on an iterative basis (Munson and Pasqual, 2012.

Gillespie-Lynch et al. further highlighted that Kim's (2013) study was about 24 children with ASD, a small dinosaur robot, a computer game and a human. The study demonstrated that children were more verbal when interacting with the robot then with the computer game or the human. They intimated more research should be carried out to demonstrate evidence that robots could be an effective therapeutic tool to provoke verbal communication. The study was not demonstrating that it took into consideration each individual's therapeutic/ educational needs, interests etc. It did not demonstrate that it had been retested with large groups of learners on an iterative basis and evaluated in collaboration with large groups of practitioners as being therapeutic/educational benefit/value for them and their learners over an extended period of time.

Robins et al. (2013) was also a small study using 14 learners with ASD investigating their tactile approach and humanoid approach to Kasper. It would have been interesting to read whether the researchers had collaborated with the practitioners and used their knowledge and expertise on the diversity of each learner and incorporated this into the learners' interaction with Kasper.

It would have also been interesting to read whether the practitioners had evaluated the use of Kasper as being therapeutic/educationally of benefit/value for the learners.

Additionally, Wainer and Ingersoli, (2011) and Ploog et al. (2013) went on to claim that some learners with ASD have difficulties with human interaction but there did not appear to be the same difficulties with them interacting with multimedia software. Jönsson, (2006:119) suggested that it would be 'easier to customise technological support than to customise human assistance'.

Fletcher-Watson (2014) claimed that in the 1990s nine experimental papers, between 2000-2009 thirty journal articles were published. Since 2010 ten studies have been published on this topic and over 345 applications (.apps) have been marketed for people with ASD but not individualised.

Beer et al.'s. (2016) study was in relation to robots, learners with ASD and music therapy. Four learners were instructed by a robot to imitate dance movements for a minimum of 6 weeks. Further recent studies, such as Wang et al. (2016) study on '11 youth' with Autism embodied social presence in a 3D collaborative virtual learning environment. Both of these were very small studies.

Simut et al. (2016) have claimed that published research findings were demonstrating that computerised technology was being successfully used as a 'mediator' for improving learners with ASD's social interaction. Simut et al. study carried out using quantitative and qualitative analysis of observations of a child with ASD and his typically developing sibling using Probogotchis (a combination of robots and computer games – a computerised toy pet). Their study demonstrated that one learner with ASD successfully used physical tactile interaction with a Probogotchi for problem solving with facial expressions being passed through sensors to a computer, once again a very small study.

There has, however, been research carried out on the use of tablets in classrooms with children with ASD.

Tablets (IPADs) and .apps

Tablets used in the classroom have been regarded by some researchers as being a successful high-tech AAC Computer Assisted Instruction (CAI) tool (Mejia-Figueroa and Jurarez-Ramirex, 2013; Kamaruzaman and Azahair, 2014). Jowett et al. (2012) study used IPAD-based video modelling software for teaching children with ASD numeracy skills. The whole holistic diversity of needs, impairments, preferences, interests etc. had not been used as a baseline with the on-going involvement of practitioners in design and development of individualised numeracy software (Frauenberger, 2015).

Mejia-Figueroa and Jurarez-Ramirex (2013), Mejia Figueroa and Jurarez-Ramirix (2014) studies had implemented Picture Exchange Communication System's (PECS) symbols into their software 'YoDiago' and android .apps. These were used with traditional methods to help learners with ASD who were speech impaired with their communication difficulties and language acquisition. These studies had not demonstrated whether the researcher/developers had collaborated with practitioners in different educational establishments for the development of individualised software, with the inclusion of PECS. The studies had not demonstrated whether the software had been tested and evaluated by large number of participant on an iterative basis, over an extended period of time.

This investigation would, however, endeavour to implement PECS symbols appropriately into individualised computerised therapeutic intervention which would be evaluated by the practitioners as being of therapeutic benefit/value for their learners with ASD.

O'Malley et al. (2014) study used 7 learners with ASD (2 females and 5 males) aged 10-13 years old with moderate-severe developmental delay in their communication, socialisation and behaviour. This study had taken into consideration the participants' gender, ethnicity disability and grade level. One teacher, an assistant teacher and eleven support workers and parents contributed in this investigation.

O'Malley et al's study was investigating the effectiveness of traditional maths instructions using a maths program on an IPAD. This was carried out in 4-5 sessions over four weeks. They used descriptive and visual analysis to demonstrate the effectiveness of IPADs for academic tasks. This investigation questions how much collaboration had been carried out with practitioners in O'Malley et al.'s (2014) study. Furthermore, whether they had taken into consideration each learner's therapeutic, educational, autistic and computing needs, likes and interests for matching them to the appropriate software. If this study had been carried out over a longer period of time, on an iterative basis, with larger groups of participants on the Autism spectrum, this could reveal the consistent effectiveness of the use of IPADs for the purpose of Maths in schools for learners with ASD.

Van der Meer et al. (2015) carried out an investigation on using an IPAD as an intervention for teaching picture and word matching to a student with ASD and severe communication impairment. Once again this was a small study. It would be interesting if these developers had considered the diversity of these learners' communication impairments and literacy skills in for the development of their .apps. This will be adopted for the development of individualised software for this investigation.

El Zein et al. (2016) study investigated the effects of IPAD assisted and teacher-directed reading instruction for children with ASD. It would be interesting to establish if these researchers/developers had taken into consideration the diversity for these learner's literacy skills in collaboration with the practitioners in their research. As this investigation has established the diversity of each learners with ASD's literacy (reading) needs, these would need to be ascertained for the development of individualised educational software.

Fletcher-Watson et al. (2016) study investigated the designing of IPAD .apps for 41 young preschool learners with ASD. Although this investigation has established the diversity of these learners therapeutic/educational needs.

This recent study was not indicating that individualised therapeutic/educational .apps were being designed and developed in collaboration with practitioners. Furthermore the .apps were not being tested with large number of learners from numerous educational establishment over an extended period of time and evaluated by practitioners as being of therapeutic/educational benefit. However, this investigation has established that mobile application are being used for learners with ASD.

Simmons et al. (2016) recent study investigated a mobile application 'SpeechPrompt', implemented by 10 SALTs in a public school with 40 learners aged 5-19 over eight weeks. They claimed that this software was designed to treat children with ASD with prosodic and communication impairments. They claimed that it helped to maintain the learner's attention whilst being used and that it was showing to be potentially useful. However, they concluded that the software needed to be further tested. Simmons et al.'s research had not indicated whether the software was individualised due to the diversity of each learner's therapeutic needs and the study was only carried out over an eight-week period as a one-off. The product needed to be tested over an extended period of time, on an iterative basis, with learners in further educational establishments, with practitioners and therapists testing and evaluating the software as being of therapeutically effective. There has been research carried out on the use of video, camera-based and virtual reality in relation to learners with ASD.

A recent study on 'Developing user interface design application for children with autism' was carried out by Kamaruzaman et al. (2016). This was approved by 'the local Research Ethics Committee of Universiti Teknologi MARA', Malysia and Ministry of High Education, Malaysia and funded by the Malaysia Government under the Acculturation Grant scheme. They claimed that computer software and mobile application need to be well developed by researchers with the user interface design being the most important part. This would result in the successfulness of the software or application in assisting the learning and development of children with autism.

Kamaruzaman et al. (2016:893) concluded in their study the importance for developers to understand children with ASD's 'cognitive ability' and to adopt a 'user model' when designing the user interface for applications for children with autism.

This investigation, however, has not found individualised .apps developed for large groups of learners with ASD (end-users), in different educational establishments, in collaboration with practitioners (users) and been tested and evaluated by them as being of therapeutic/educational benefit/value over an extended period of time.

Nevertheless, the researcher's understanding, some learners with ASD have tactile difficulties and are unable to touch and look after a live pet. They are, however, able to take care of a computerised pet, feeding it, playing with it, stroking and holding it with an on-screen animated hand in a virtual computer 'Dogz' game. These transferable skills have been potentially successfully used to encourage interactive play with real dogs in the home environment.

Video/Camera-based/Virtual Reality

Brooks (2011) study demonstrated the effective use of Soundscape's camera-based EyeCon software and the sensing and mapping of gestures and content, to monitor each learner's expressions, gestures, sign and body language. He indicated that its purpose was to encourage carers and therapists who were computer phobic to participate with disabled learners. Intriguingly Brook's (2011:315) article mentioned 'the aforementioned video exemplifies further with an autistic learner'. It would have been interesting to read whether this autistic learner's needs had been taken into consideration and what the specific outcome had been. Furthermore, as some of the learners use signs, gestures, body language (Ganz et al. 2012; Blood et al. 2013) it would be interesting to establish if the EyeCon software could be used alongside individualised computer software in collaboration with practitioners as a therapeutic/educational intervention.

The researchers (Frauenberger et al., Porayska-Pomsta et al. 2012; Bernardini et al. 2014) of the ECHOES project has highlighted that it is vital for there to be a close collaboration between researchers and practitioners. This project used an Action Research (AR), Participatory Design (PD), Human Computer Interaction (HCI) and Artificial Intelligence (AI) methodological interactive practice-driven interdisciplinary approach. The aim of this investigation was to establish the development of Technology Enhanced Learning (TEL) to facilitate acquisition. It further explored the social skills of 5-7-year-old Typically Developing (TD) children and high functional ASD children. Three cameras with positioned on the sides and top of the screen enabled real time head position and eye gaze detection. This was to observe children interacting with the on-screen intelligent, semi-autonomous virtual characters (embodied agents) and interactive objects on on-screen socially realistic situations in a multi-model 3D sensory garden. These agents facilitated learning activities with specific goals. Although the researchers established each learner's age, gender and preferences, however, the researchers did not stipulate that they have taken the diversity of each learner's autistic, therapeutic and educational needs into consideration (Davis et al. 2007; Wing et al. 2012; Table 2.11:62). The researchers claimed they had collaborated (Frauenberger et al. 2012) with practitioners and parents and took into consideration emotional regulation and recognition, categorisation abilities, thematic interests and communication the literacy skills. Fraunberger (2015:57) a post-doctoral researcher on the ECHOES project, observed the video captures of the children participating in the project. Off-screen the children were interacting, using gestures, 'with others in the room.. whilst using the product'. It appears that some learners had difficulties with generalisation across content and language structures.

Gillespie-Lynch et al. (2015) evaluated studies on face recognition computerised games for learners with ASD. Gillespie-Lynch et al. (2015:41) concluded that research is beginning to demonstrate the range of computerised and tablet-based resources were providing these learners with many opportunities to …tailor interventions to specific individual needs.

Gillespie-Lynch et al. claimed, however, that virtual reality was looking a promising intervention tool for learners with ASD's social-emotional development. They suggested that learners with ASD 'should be involved in selecting, modifying and designing their own application to support their own development and the development of others with ASD'. They suggested that many of the software, not developed for learners with ASD, could be of use for them if they are could be adapted and adopted to fit each of these learners' needs.

The investigation concurs with Gillespie-Lynch et al. that technologies should be used alongside other interventions and suggests that researcher/developers need to collaborate with practitioners in the design, development and evaluation of individualised software for ASD.

2.10 Software developers

Several researchers over the years (Thornbury, 2005; Kovalik and Kuo, 2012) have complained about the many problematical issues relating to software produced for the mass market and often labelled as suitable for learners with special educational needs being used in schools.

Generic software is being developed and used in schools and seems to adopt a 'one fits all' ethos. The literature review has demonstrated that researchers and software developers were not taking into consideration the autistic learner's impairments and difficulties and did not encourage the use of verbal response through personalisation or verbal interaction. Herskowitz, 2001; Munson and Pasqual, (2012) argued that, off-the-shelf multimedia software had some entertainment value and agreed with Jones, (2006) and Shane et al. (2011) that it was also educationally effective for some learners with autism.

The researcher, further agrees with Thornbury, (2005) and Kovalik and Kuo's (2012) complaints concerning the limited, generalised, commercialised, inappropriate and poorly made, over-priced, off-the-shelf software being developed.

They further claimed that software was over-rated, lacked reinforcement, was of limited educational value, difficult to use, had distracting scenes and were not directly addressing or taking into consideration each autistic learner's spectrum of needs.

Furthermore, school staff was unaware of the availability and use of multimedia software, owing to their lack of time, skills, stimulation, motivation and reluctance to explore unknown resources (Knickelbein and Richburg, 2012). This may well be due to the range and degree of difficulties associated with their learners (Inclusive Technology, 2004a; Miller et al. 2014) or with software not specifically developed for their individual learners (Davis et al. 2010).

The researcher questions whether this may have been due to difficulties schools have with changing their policies and exploring new and existing multimedia software, which they could use for each of their autistic learners' education and language development. Conceivably, practitioners may just be content with the familiarity of their existing software even though, they did not have a continuous collaborative role in its development, and were not able to evaluate the software's suitability for meeting each learner's needs.

To identify, evaluate and match the appropriate therapeutic/ educational generic software to the variance of each learner's needs (Tables 2.1 and 2.2:14), would be an enormously time-consuming task for practitioners to achieve on top of their already stretched time-constraints.

There is numerous commercialised generic off-the-shelf software developed for learners with autism and other disabilities. The researcher was, however, unable to establish any published quantitative and qualitative evidence as to whether commercialised, generic, off-the-shelf, standardised software had been developed using a holistic Design-For-One collaborative approach. Studies were not demonstrating that they had taken into consideration the diversity of each learners' needs (Davis et al. 2007; Aspy and Grossman, 2014; Table 2.11:62).

Baron-Cohen et al. (2012) claimed that some of the computer-based and social skills training programs are still ineffective due to not adopting teaching methods and lack motivation. The ineffectiveness of some programs could be due to studies not endorsing the gaps and concerns, which have been highlighted in this investigation, but could be given additional consideration in further studies when multimedia therapeutic/educational software is being developed for learners with ASD. The researcher's supposition, therefore, is that computers can also be considered as a communication aid for therapists and school staff to use to help some learners' speech and language development. Practitioners (therapists and educationalists) would then need to collaborate with software developers in an endeavour to make therapy and education a fun way to learn through play using computers in schools (Thiemann-Bourque et al. 2012; Freeman and Kasari, 2013).

Wainer and Ingersoli (2011) claimed that researchers should compare the use of some intervention techniques utilised across computer delivery instruction with more traditional therapist or classroom based instruction format. The researcher agrees with this and further suggests that in order for practitioner's satisfaction, they could divulge to software developers any effective traditional approaches, methods or strategies they were using which could be adopted in therapeutic/educational computer software. The researcher is agreement with Wainer and Ingersoli that no matter how effective an invention is, without the 'consumers' (practitioners) satisfaction and acceptability the program would not get integrated for use in the classroom.

2.11 Summary

This investigation had not established any studies which have undertaken an iterative, collaborative approach for the on-going development of personalised tailored software with practitioners resulting in them evaluating (Frauenberger et al. 2012) the therapeutic/educational usefulness, benefits and value of the individualised software for their learners with ASD.

This investigation has established that there is a significant amount of research being carried out at universities and research centres in relation to learners with ASD, however, academics are in general not collaborating with practitioners in school.

Small studies

This investigation has established past studies were carried out on small groups of learners and not retested and evaluated on an iterative basis (Wainer and Ingersoli, 2011; Dickinson et al. 2013; Yakubova and Taber-Doughty, 2013). Such an approach persists with recent studies (Mejia-Figueroa and Jurarez-Ramirex, 2013; Figueroa and Jurarez-Ramirex,, 2014; Korhonen et al. 2016). Korhonen et al's. (2016) used minimally verbal learners with ASD with highly supported needs. They claimed that there has been less research being carried out with this group of learners in comparison to high-functioning learners with ASD. This will be addressed within this investigation individualised therapeutic/ educational software is produced for large groups of low-functioning learners with ASD over an extended period of time.

Wainer and Ingersoli (2011) have researched 14 studies (over years 1995-2010), which used innovative computer technology for teaching social communication to learners with ASD. They concluded that software developers and researchers need to be aware that past studies were being carried out on relatively small sample sizes of similar learners. The studies were not transferable to larger and more diverse samples of learners and sub-populations of the society with ASD. This corroborates with the findings already established in this chapter by the researcher (Parsons et al.; Wainer and Ingersoli, 2011; Yakubova Taber-Doughty, 2013).

Miller and Bugnariu's, (2016:246) own literature review findings demonstrated that studies were 'limited by high variability of sample characteristics and methodology'.

Beer et al.'s, Wang et al.'s and Simut et al.'s (2016) research once again demonstrated that studies were still being carried out on a relatively small number of participants, tested over a one-off period, in one educational establishment. This investigation suggests it is critical to work in collaboration with practitioners. The reason for this is that practitioners have the professional expertise and knowledge of each learner's diversity of autistic, therapeutic/educational needs. The practitioner's input in the design and development of computerised interventions may result in more effective individualised products being developed. Their evaluation of the therapeutic/educational effectiveness of products would result in practitioners implementing the products (software) in the classroom.

These anomalies will be taken into consideration within this investigation ensuring the involvement of large groups of participants, transferable to other learners and practitioners in further educational establishments, on an iterative basis over an extended period of time. This was because the researcher further questions whether for these learners with ASD, does what works once, works again, if repeated?

What works once

This investigation suggests that interventions need to be repeatedly tested over a period of time in different environments and with many participants on an iterative basis.

Learners with ASD may react differently to interventions if repeated, e.g. what works once sometimes does not work again, this is due to their intolerance for change of structure, their therapeutic, educational, behavioural impairments and their transition and inconsistency difficulties (NAS, 2010a; Volkert and Vaz, 2010). Products should, therefore, be tested with large groups of participants (users and end-users) in different environments in order to demonstrate the reliability and validity of the consistent effectiveness of the intervention.

2.12 Conclusion

This review has demonstrated that learners with ASD had a diversity of needs with (Davis, 2007) autistic, therapeutic (language and communication), educational (literacy and numeracy) needs, impairments, multimedia modality and element preferences (Berk, 2011), strengths, weaknesses, likes, dislikes and interests (Table 2.11:62).

There has been an abundance of drill and practice software developed, however, practitioners hare concerned as to how the software could be used for speech and language development and learning within their teaching targets given their limitations, availability, lack of time and skills. The therapeutic and educational advantages and disadvantages of the use of computers and the benefits of educational software have been discussed (Table 2.7-2.10:32-36).

Specifically there was evidence that multimedia technology through the combination of multimedia elements have improved to be of therapeutic benefit/value with positive evidence of the effectiveness of the interaction of the practitioner (Shane, 2011; Munson and Pasqual, 2012).

The review findings are claiming that multimedia could help social interaction, lack of social imagination (Reed et al. 2011; Wing et al. 2012) and difficulties with the rigidity of thought through stimulating and motivating some visual, auditory and/or tactile learners. This could give them a safe, calming, reassuring, predictable, structured and purposeful 'language-world'. There was no evidence that the software developed had taken into consideration the diversity of each learner's needs, etc. (Table 2.11:62) through iterative collaboration with practitioners.

Many studies are using small groups of participants (Parsons et al. and Wainer and Ingersoli, 2011; Yakubova Taber-Doughty, 2013) and not demonstrating that practitioners worked in collaboration as co-designers, co-developers, co-evaluators with software developers (Porayska-Pomsta et al. 2012; Fletcher-Watson, 2014) on individualised software.

Although, the literature review has shown that researchers and past studies (Trehin, 2002; Tuedor, 2009 cited and reported by Stokes, 2008a-2008d) have generalised as to the therapeutic and educational impact and benefits of multimedia software for some learners' communication, motivation of speech and reading. Past research was not demonstrating that researchers/developers collaborated with practitioners resulting in practitioner's evaluation (Frauenberger et al. 2012) as to the benefit/value of therapeutic/educational individualised software.

This review did not demonstrate the effectiveness of individualised therapeutic/educational software, developed on an iterative basis, over an extended period of time, for large groups of participants supporting learners with ASD and in many educational establishments. In summary Table 2.11:62 identified the gaps and areas of concern identified in this review. These led to the formulation of the objectives, (Table 2.12:63) the research questions (Table 2.13:63) and the aims of the investigation, which is to establish if the therapeutic (language and/or communication) and educational use of individualised tailored computer software developed for practitioners, are being met.

Table 2.11 Gaps and concerns highlighted by this investigation

Gaps and areas of concerns from the research findings
Many studies were using small groups of participants (Parsons et al. and Wainer and Ingersoli, 2011)
Studies were not demonstrating that developers and researchers were collaborating with practitioners.
Studies were not demonstrating that a holistic approach, which took into consideration the variance of each learners' details and needs and used as a baseline (Wing et al. 2012; Aspy and Grossman, 2014).
Past studies were not indicating that a Design-For-One approach was being adopted.
Studies were not indicating that products had been evaluated by practitioners prior to implementation (Frauenberger et al. 2012 and Sanches-Ferreira et al. 2013)
Research findings were not indicating that practitioners were claiming that the products had been therapeutically/educationally effective for them and their learners? (Thornbury, 2005 and Kovalik and Kuo, 2012)
Iterative uses of products were not shown as being used in past studies.

Table 2.12 Objectives based on gaps and concerns

Objectives based on gaps and concerns
To adopt an iterative collaboration with practitioners
To ascertain from practitioners the variance of each learners with ASD's details and needs.
To adopt a holistic and Design-For-One approach.
To enable the multimedia software development team (university students and academics) and practitioners evaluate the individual computer games for quality control before implementation in the classroom.
To enable the process to be carried out with large groups of participants on an iterative basis.

Table 2.13 Research questions from this investigation

Research Questions
How does a CMT/EI process enhance the development of computer games for learners with ASD?
What are the barriers and opportunities of such a process?

The following chapter discusses the methodology used for the continuous development of bespoke software, by annual cohorts of students, for large numbers of learners with ASD, with the researcher in on going collaboration with many practitioners in different educational establishment over an extended period of time.

Chapter 3
Research Methodology

3.1 Introduction and structure of the chapter

This chapter gives the researcher's personal and professional perspectives and epistemology viewpoints. It gives an overview of a number of research methodologies such as Participatory AR (PAR*),* Practical/mutual/ collaborative/deliberate mode, Hatt and Bond's seven types of AR methods, the adoption of the type of action research used by this investigation and Collaborative Action Research in Education (CAR-E). It highlights why McNiff's AR approach had been adopted for this practice-based investigation. This was through a process by which cohorts of university students would design and develop individualised fun therapeutic/educational multimedia games for learners with ASD (end-users). The chapter continues by highlighting the advantages and limitations of action research. It demonstrates the cyclical methodology used for the process and product and as to what was learnt from each stage of the process.

3.2 The researcher's personal and professional perspectives

The researcher's personal perspectives stem from her ethnic origin, theology, nurture, experiences, comprehension of the cosmos, imagination, intuition, consciousness, sub-consciousness and thought process.

Adams (2011) identifies how:

> we aspire to holistic action in the world, our ways of knowing are fragmented. We assume that we can understand the world best by breaking it down into its parts looking at reality through a kaleidoscope of lenses – social, cultural, historical, theological, and economic.
>
> Adams (2011: 240)

Therefore, if we (not on the autism spectrum) find our world very complex, full of unpredictability, changes, unstructured, inconsistent and at times incomprehensible to cope with. It is not difficult for us to comprehend how disturbing our world must be for those learners on the autism spectrum whose world is that of structure, consistency, predictability, without changes and deviations.

Throughout the investigation, the researcher needed to make choices in order to answer the regarding 'what' and 'how' research questions. The researcher understood that it was important to indicate her significant perspectives over the years.

The first significant perspective transpired through her awareness brought about by the challenges of being a Roman Catholic from a mixed cultural background, marrying a non-roman catholic man and jointly being parents of three children with different challenges and difficulties. These have contributed to her ontological perspective.

Over the years her 28-year-old autistic daughter with epilepsy, severe challenging behaviour, fine and gross motor difficulties and severe learning difficulties was taught in many education environments. This began with opportunity class through to nursery, mainstream school, a special school for children with physical disabilities near her Hertfordshire home, to an autistic establishment in Aberdeenshire, Scotland and finally, most appropriately, a placement at a residential autistic college/home in Yorkshire.

In order to be placed in these establishments specialising in autism, the researcher had to fight and win two tribunals against the Social Services, Local Education (LE) and Health authorities, (whilst in fulltime employment as an academic and carrying out this investigation).

The researcher continues to attend annual reviews, working in collaboration with a multidisciplinary team of professionals (teaching staff, speech and language therapists, Physiotherapist, Occupational therapists and Educational Psychologists. Furthermore, the researcher has first-hand experience of the autism world including learning Makaton Sign language, TEACCH and Now and Next strategies to help her daughter who has with limited verbal skills to communicate.

From experiencing both mainstream and special needs education environments the researcher gained knowledge of the educational systems and the autism community.

The researcher is a member of the National Autistic Society and has attended many events meeting many young and mature autistic people and their carers over the years. She is also a Community Governor and the chairperson of the Schools Improvement Committee of a local (special needs) primary school for up to 71 pupils with Complex Learning Difficulties including Autism Spectrum Disorder, Speech Language and Communication Difficulties, and Attention Deficit Hyperactive Disorder (ADHD). These experiences have enabled her to understand the diversity and variation in the spectrum of needs and developed the further moulding of her ontological perspective in relation to the Autism, special educational needs and therapeutic (speech and language) worlds. Her understanding of the academic reality was through herself as a student in academia and as an academic (programme leader, module leader, lecturer and tutor).

Academic perspectives

The second perspective assisted in further shaping the researcher's academic perspective, was through an understanding and her implicit views of the academic reality. This was achieved through her life as a mature, joint BSc (Hons.) Information Technology and Education Studies student. The researcher gained further information regarding special education needs and computing areas through studying the Special Needs and Computing studies modules.

Working in collaboration with teachers and speech and language therapists, she was able to carry out assignments, projects, pilot studies and a final year dissertation.

Consequently, over the years in academia her reflection on students carrying out assignments and coursework was that they wanted to attain the best grade possible and not merely to pass their studies. This led her to believe that the efforts made by students, should not end in the storage of their work or their efforts or disposed of as waste. This guided her to propose and lead a meaningful assignment for the students (explained further in this and the next chapter) with students producing products that would be of use to someone in the real world, which should result in more efforts made by the students (O'Brien, 2001).

The third perspective was achieved through her career over 20 years as an academic as a multimedia university lecturer and researcher. The researcher's continuous professional development and knowledge was gained from pilot studies, conference talks, poster sessions and refereed conferences and journal articles and book chapters in national and international publications (Stokes et al. 2001; Stokes, 2003a-2014b; Stokes and Whitney, 2008) covering areas relating to autism and computers.

Her pedagogical views of the reality of academic life, over the years, developed her reflection on students' assignments. The purpose was not to just develop coursework that would merely assess their understanding of the course but to produce a more purposeful assignment for them. The aim would be for students to develop a product both as their coursework and for research purposes for an autistic community of (real) learners in society. This led to an investigation as to whether computer games could be developed as a therapeutic and/or educational aid for practitioners (teachers and speech and language therapists) supporting learners on the autism spectrum. The students' concluding efforts would be of potential use to others even after they had graduated.

Some students obtained part-time jobs for the disability community whilst continuing their studies. Some chose to continue implementing projects in relation with disabilities collaborating with the appropriate professionals. One graduate demonstrated the product she had developed for an autistic pupil in the local community whilst studying the lecturer's multimedia module, at her job interviews with Hewlett Packard UK and Microsoft UK. Both companies were very impressed with the product she had developed for a real disabled member of society and offered her a position. Microsoft UK now employs her.

In reality the researcher's views as a parent, a governor, an academic, a multimedia practitioner and lecturer has had an effect on her relationship with the subject matter (Brooks, 2011; McNiff, 2013). The subject matter being autism, education, special needs, speech and language therapy, student's learning and motivation, computers, multimedia (Chevalier and Buckles, 2013). This has influenced how the researcher sees the participants (herself, the students, the practitioners) and the learner/pupils.

The researcher views her position and her collaborative relationship with the participants in this investigation (McNiff, 2013) as an insider (as a parent/governor) and as outsider (academic/researcher/participant). This is of what she knows and how she came to know things about the reality of this world (MacIntosh, 2013; McNiff, 2013). Furthermore, the researcher's ontological concepts and her general and professional knowledge (epistemological viewpoints) assisted in the justification of the appropriate chosen research methodology.

3.3 Research methodology

The investigation underwent an analysis of the strengths and weaknesses, bias, reliability and validity of numerous research methodologies such as ethnography method, social survey method, experimental/quasi-experimental method, participant observation methods, historical method, correlation method, Ex post facto method, methodological triangulation method, Longitudinal study, Action Research method and Evaluation Research method.

This resulted in choosing an Action Research method for this investigation. This was achieved by establishing which methods would be appropriate for this investigation and which ones would be rejected. It enabled the researcher to understand how methods could be used with the process and project in further future investigations (Institute for Work Based Learning, 2012).

3.4 Action Research (AR)

Kurt Lewin a professor at MIT coined the term Action Research in 1944 (Case and Light, 2011; Bruce and Rowell, 2016). By the 90's Carlhoun (1993) claimed that there were three types of AR in Education:

- Individual AR - Working independently (teacher carrying research on class)
- Collaborative AR (Group of teachers/researchers working together to explore a problem in a classroom)
- School-wide AR (issues throughout the school being resolved by teams of staff member carrying out the project together).

As the aim of this investigation was to support practitioners by solving the therapeutic/educational problems of their learners with ASD, a Collaborative AR was appropriate for this study.

Myers, (1997:241) indicated that action researchers could be divided into three categories – positivists, interpretivists and criticalists. Myers claimed that positivists or classical action researchers use a social experiment and can be regarded as an accepted approach to 'test hypotheses in a real-world environment' thereby being more appropriate for this investigation which would be dealing with therapeutic/educational problems in schools.

Berg, et al. (2004:206) however categorised Action Research methodologies as one of three types 'technical/scientific/collaborative mode, a practical/ mutual/collaborative/deliberate mode and an emancipating/enhancing/critical mode'.

The ‘practical/mutual/collaborative/deliberate mode’ was the most appropriate for this investigation (Table 3.1:71). This method is used to define needs and problems, increase awareness, influence design making and improve the participant’s understanding and practices through a collaborative investigation with trained researchers, professionals and lay people. This resulted in empowering practitioners to be active participants in change through the development of appropriate interventions.

This investigation discusses the many types of AR (Table 3.2:72) methods and highlights, which were appropriate and thereby adopted for this research.

Bowling (2006, 2014) highlighted Hart and Bond’s alternative seven types of AR methods (Table 3.3:73), resulting in this investigation adopting a Participatory AR (PAR) method.

Participatory AR (PAR)

McPherson and Nunes, (2004) and Kemmis et al. (2013) stated that the responsibility of the PAR, Critical PAR and Educational AR is on the participants only.

For this investigation, however, the researcher is fully involved in a meticulous enquiry, carrying out practical actions to solve specific problems through change in a situation, resulting in generating knowledge.

The intention for this investigation was not to create a debate challenging the traditional innovations, which were already demonstrated as being successfully used by teachers and SALTs (Chapter 2:8) with some learners with ASD.

Table 3.1 Practical/mutual/collaborative/deliberate mode (Berg, et al. 2004:206)

A practical/mutual/collaborative/ deliberate mode	The AR approach used for this investigation
'*Researcher and practitioner together collaboratively identify potential problems and issues that underlying causes and possible interventions'.*	Each learner's therapeutic/ educational problems will be identified by the practitioners.
'*Researcher and practitioner research problem defined after both have assessed the situation and reach mutual understanding'.*	Practitioners would be able to identify problems, which will be addressed by this investigation.
'Seeks to improve practice-and-service, delivery of the practitioner through application of the personal wisdom of the participants'.	The learners (end-users) in this investigation are unable to communicate their wisdom. The practitioner would be able to use their knowledge and expertise to identify this.
'Communication starts with researcher and facilitator working collaboratively and then flows from the practitioner (facilitator) to the group of stakeholders'.	The researcher and practitioners will be working collaboratively in the design and evaluation. Communication will flow from the researcher to the students on feedback from the practitioners.
'Design more flexible approach than technical/scientific/collaborative mode in that it embraces a great concern for empowering the emancipating stakeholders works with the practitioner'.	It will be *empowering and emancipating* the practitioners through their on-going involvement in the process.
'Gain in flexibility and effects of emancipating participants does, however reduce some degree of measurement precision and control over interpretation, interactive communications, and detailed descriptions. Not seen as the primary goals – the goal of practical action researchers is understanding practice and solving immediate problems'.	The goal for this investigation is in understanding of each learner's language, communication, numeracy and literacy needs. This would be achieved through the adoption of a holistic approach to solve individual therapeutic/educational problems.
'Practitioners tend to reflect on their own practice styles, incorporate new information developed by the research and implement interventions that may affect lasting changes in the groups with whom they participate'.	Practitioners will be given the opportunity to reflect and report on any effective therapeutic/ educational methods they use which could be incorporated into individualised computerised interventions developed in this investigation.
'The interventions may cease to be used when these individuals leave the system'.	This may also be case with the individualised software developed through this investigation as the learners move to other educational environments.

Table 3.2 The adoption of the type of action research used by this investigation.

AR methods	Adopted/not adopted by this investigation
Industrial AR (Kemmis et al. 2013)	This will not be adopted by this study as this is not a consultant-driven investigation collaborating between social scientists and members of different levels of an organisation and need for the effectiveness organisations, employee relationship and change in social systems. This investigation, will be taking on a humanistic and individual approach endeavouring to 'learn from trying to bring about change…' (Kemmis et al. 2013:10).
Action Science (Kemmis et al 2013; Herr and Anderson, 2014)	This investigation is not a study between 'academic organisation psychology and practical problems…' in school and academia for the improvement in these settings. (Kemmis et al. 2013:10)
Action learning (O'Brien,1998; Kemmis et al. 2013)	This investigation will not be adopting this approach. It is not the intention of this study for the management of problems in an organisation or to bringing people together to learn from each other's experiences. It is not the intention of this investigation for the researcher to study her own situation as a lecturer in the university problem-solving areas to achieve the university's vision. As with this method, it is the intention of this investigation to also learn from the expertise of the practitioners the diversity of each learners' needs.
Soft system approaches Kemmis et al. 2013)	This investigation does is not going to be involved in 'hard Systems Engineering, industrial production, a human system analogy of system Engineering, a science of product and information flow….' (Kemmis et al. 2013:10). Although, the researcher will not be considering herself to be trainer for a real problem, but will be in a partnership discussion with practitioners and will be teaching the students to develop software.
Education AR. (O'Brien, 1998) /Classroom AR Kemmis et al. 2013)	This is a Community problem-solving method. Practitioners carrying out research in educational institutions with a focus on development of curriculum, professional development and applying learning in a social context (O'Brien,1998). Kemmis et al. (2013) referred to this as Classroom AR. Although this method specifically uses qualitative methods, this investigation will be using both qualitative and quantitative methods. Classroom AR approach relies on teacher's data collection to self-understanding and judgement as to their own practice and for making improvements. This investigation will be providing a template in other for practitioner to in part their knowledge and expertise. As the emphasis of this method is practical, the investigation will be endeavouring to demonstrate its practicality through the interpretation of the practitioners' knowledge and understanding of the learners' therapeutic/educational diversity of needs for the development of individualise software.
Practitioner/Teacher AR (Herr and Anderson, 2014)	Although the researcher (the outsider) would be working in collaboration with practitioners (insiders). The practitioners themselves are not going to be considered in this investigation as being the researchers in the centre of the project.

Table 3.3 Hatt and Bond's seven types of AR methods (Bowling 2006:411)

Types of AR methods	Used by this investigation	Types of AR methods	Not used by this investigation
Educative	To enhance the diversity of each learner's (end-user's)… Therapeutic (Language and Communication) needs and Educational (Literacy and Numeracy) needs.	Deals with individuals as members of social groups	Not as a group but as individuals due to their diversity of needs
Problem-focussed, context-specific and future-oriented	Will be problem focussed if highlighted by practitioners (users) on each learner's profiles)	A change intervention	Not a change of intervention but for using alongside of interventions
Improvement /and Involvement	To improve each individuals' therapeutic/ educational needs through the involvement of the practitioners (users)	Cyclic process in which research, action and evaluation are interlinked Founded on a research relationship in which those involved are participants in the change process	Using an iterative cyclical process for the development of individualised computer games, through the on-going collaboration, input and evaluation of the practitioners (users) Not founded on a research relationship in which those involved are participants in the change process

The researcher/practitioners in this investigation will share the ownership of this community-based project through an analysis of the diversity of the therapeutic/educational needs for learners with ASD (Brannick, and Coghlan, 2010). It was, important to work in collaboration with practitioners in a participatory process as they had the expertise and practitioner's knowledge of each learner's diverse spectrum of needs, their modality preferences and each learner's interaction with objects, people and the environment at a given time (Brannick and Coghlan, 2010; James et al. 2011).

Accordingly, this investigation sets out to discover the potential use of an intervention developed through the collaboration of the practitioners as participants.

Consequently, action research methodology was chosen as the appropriate methodology for this investigation as the research would be undertaken in the practitioners (users) and learners (end-users) everyday working environment (classroom) and cohorts of students in an academic environment would be developing individualised software on an iterative basis.

As Brooks (2011) states:

> Action research is a methodology conducted with the situation that is being studied towards change where it is acknowledged that the researcher can have an influence…
>
> Brooks (2011:19)

The use of an AR methodology, would be enable the researcher to influence practitioner's (users) to use their professional knowledge gained over the years (Whitehead, 2002; Case and Light, 2011) for the input and design of individualised computer software for their learners. It is hoped that the participatory process would change their perception and empower the users (and their learners (end-users)) with a therapeutic/educational individualised aid.

The design is congruent with Case and Light, (2011) as to the importance of taking into consideration the user. Furthermore, it will not just be adopting a practical approach for improving therapeutic/educational methods, which have already demonstrated to be of use (Case and Light, 2011). It will be adopting a more individualised holistic approach by the researcher leading the whole investigation. This will be achieved by the researcher facilitating and ensuring continuous collaboration of all the participants and working with academics and students at a technical level. This would result in the analysis of the findings and disseminating the results to the appropriate participants.

It would not be appropriate to involve the practitioners in all the technical aspects of the process. Instead practitioners (i.e. the teachers) would be able to reflect on the outcomes of the investigation to enable them to 'develop their practical understanding' of the appropriate intervention for each end-user (Case and Light, 2011:197).

The use of this methodology could help practitioners identify and recognise areas in their therapeutic/educational practices, which may need changing. This could give practitioners an understanding of the importance of identifying each learner's details and needs (Chapter 2:8) before implementation

This study is not the first to use students within an AR methodology. Jorgensen and Busk Kofoed (2007) used students and an AR methodology in their 2007 study for integrating the development of continuous improvement and innovation capabilities into Engineering education.

Case and Light's (2011) discussion on Jorgensen and Busk Kofoed's study claimed that:

> bringing in students as active participants in the cyclical nature of the research, including planning and generating ideas and solutions, meant that the research began to engage them in continuous innovation as well as continuous improvement.
>
> (Case and Light, 2011: 198)

Herr and Anderson (2014) have discussed a community-based participatory research. They have claimed that 'AR has gained a small foothold among researchers and participants as an advantage to ecological validity'. Due to the self-interest of the researcher, she will be working collaboratively with the participants (practitioners and university students) with the use of a 'generic umbrella term' Education Participation Action Research (EPAR).

This was adopted not only for the researcher's individual academic professional development but also as a collaborative rout to professional and institutional change (Herr and Anderson, 2014).

McNiff's approach

The researcher adapted and modified McNiff's (2013) action-reflection cyclical approach within this AR type as it is a:

> spontaneous, self-recreating, extended iterative systematic action-reflection, spiralling process through observing, describing, planning, acting, reflecting, evaluating and modifying [approach].
>
> (McNiff, 2013:57)

The researcher agreed with McNiff's concepts that learners with ASD should be considered as being equal and should enjoy the same rights and entitlements as others.

Hence, the practitioners should be aware of these learners' diverse spectrum of needs when developing and implementing therapeutic and educational interventions. Consequently, this investigation needed to recognise the importance of using the practitioner's expertise and good practice.

McNiff, (2013) interestingly highlights:

> If [the practitioners] consider [their] practice [to be at a] good [standard], how can [the researcher] develop from their success to deal with an uncertain future? However, if [practitioners - users] consider it less than good, how can [the researcher] improve it.
>
> (McNiff, 2013: 29)

Thereby, this investigation will adopt good practices and will hope to improve on any less good practices. This will be achieved using AR methodology to assist in building upon the user's knowledge and understanding of the end-user by developing an appropriate therapeutic and educational intervention for them and for their learners.

McNiff's (2013:28) suggestion that 'commitment to the idea that learning will transform into purposeful personal and community action for social benefit' will be achieved in this investigation through an iterative AR methodological cyclical approach.

It was interesting that the participants' (users, students and researcher) own understanding came from their experiences of living and learning. The learning must not just occur in the classroom (school, college or university) but also in daily living, as action researchers regard learning and experience as a process.

Berry (2000:10) stated, it was important to use action research to 'act on the basis of what we know, and what we know is incomplete…since we keep on learning more'. The assumption of this investigation is not that the researcher is 'the expert' with the participants in the investigation not playing an active role. Conversely, for this investigation the users (practitioners) were regarded as being the experts and would play a collaborative role in the design and in evaluation of the product, resulting in providing feedback through an iterative process.

The action researcher accordingly reflected on her own practice as a past student as an academic over many years and her relationship with students. Her reflection on her collaboration with a multidisciplinary team of professionals, over the years, and the reflection of her personal experiences regarding the limitations of speech and language therapy, concluded in the development of a unique assignment. This was used on a continuous basis with cohorts of students studying her module with her constant collaboration with practitioners.

This assignment would be carried out through stages to examine the evidence that individualised software could be developed and would be of therapeutic/educational use for practitioners and their learners. National and international publications, meetings and workshops were given by the researcher to demonstrate the benefits of using the AR method for this investigation.

This helped to gain further data and information thus generating theory and knowledge and professional development for the researcher. This was disseminated in the researcher's article in the International Journal for Human Development (Stokes, 2008a) and her conference paper for the National Autistic Society Neuroscience conference (Stokes, 2008b). The investigation would, thereby, make an impact on society and enable:

> society and colleagues to apply findings from the research, but it also may open the door for future collaborative action-research projects that will continue the cycle of improving teaching and learning.
>
> (Ross-Fisher, 2008: 162)

This investigation, however, needed to question whether using AR methodology would:

> generate knowledge, about how knowledge is produced within and through relationships and what kind of relationships are necessary for this purpose.
>
> (Whitehead and McNiff, 2002, xii)

The study suggests how using this methodology demonstrates how knowledge has been produced by relationships, which in turn generates further knowledge. The investigation suggests a continuous collaborative relationship with the development team and users through a mutual understanding, by listening to the needs of others and by giving advice emphatically to all the participants. This could lead to a collaboration with others in further future developments.

McNiff (2013:31) further questioned whether using this methodology has resulted in whether we have 'learned with and from [each] other' and as to what all the participants will do, with what they have all learnt.

Ferrance, (2000:6) claimed that there are many different descriptions as to the steps in AR. The basic concept is the same 'empowerment of participants, collaboration through participation, acquisition of knowledge, and social change'.

Furthermore, McNiff (2013:7) argued that the use of a 'set of techniques, or required the execution of a specific set of steps or actions' turns [AR methodology] 'into an oppressive technology that denies the humanitarian and egalitarian ideologies that inspired the action research movement in the first place'.

Although the researcher may agree with McNiff (2013) this investigation used a caring and equal opportunistic approach brought about by the researcher's ontological concepts, empathy and personal knowledge, understanding and experiences of all those involved in the autistic world over 25 years.

3.5 Advantages and Limitations of AR

Advantages of Action Research

Researchers (Bradbury-Huang, 2010) have claimed that there are many advantages of using AR methodology such as it being a systematic approach for collecting information and identifying real problems and concerns.

Furthermore, it has been suggested (McNiff, 2013) that the strengths of AR are in small-scale problem-solving studies carried out within a particular environment with the use of Stinger's 'Look, Think and Act' process (Bowling, 2006, 2014). This investigation will explain fully in Chapters 4 and 5:88 and 129 how small and large samples were used to demonstrate its cyclical maintenance.

This study, however, adopted Kaientz, et al's. (2007) claim that this:

> approach is only action research when it is collaborative, though it is important to realise that action research of the group is achieved through the critically examined action of individual group members.
>
> (Kaientz, et al. 2007: 5)

Further advantages of adopting the AR method in the case of this investigation was that it gave an interactive foundation and baseline. This helped the development and improvement of teaching and learning practices for academics, students and the practitioners (Burns and Ysseldyke, 2009). The investigation endorsed Ross-Fisher's (2008) claim regarding the benefits of the length of time of research due to the researcher acquiring and basing the findings on many years of published evidence. Consequently, the length of time gave:

> an impact on the strength of results; a study conducted for a period of two or three weeks is not as conclusive…[however] …the process for action research, an actual strategy, technique, or "intervention" intended to elicit change must be implemented for a specified length of time.
>
> (Ross-Fisher, 2008:162)

Limitations of Action Research

De Jager, (2002) and Bradbury-Huang, (2010) claimed that researchers using the AR method could be unclear about the processes or how the outcome would be achieved. Schneider, (2012) indicated this method could be invalid and unreliable due to its minimalist audience.

Ferrance, (2000:3) went on to highlight another drawback of action research as 'that it may not be shared with others'. Herr and Anderson (2005) have also questioned the validity of AR methodology as to the 'trustworthiness of the inference of the data'. They also question whether the data extracted using this methodology could be generalise across a larger population or transferred to other populations.

This investigation suggests that these problems can be rectified through the iterative collaboration and including the practitioners' knowledge, expertise and evaluation for quality control with an initial large cohort on an iterative basis extending to other populations.

These limitations were also overcome by the researcher as the clarity of the process assisted in her understanding of how the outcome could be achieved.

The intention of this study is to also resolve the limitations of the minimalist audience with the use of vast number of collaborative participants (users and students) shared in the data and information gained throughout the investigation. Additionally, this methodology was adopted due to advantages of carrying out this practice in both classroom and academic environments using the collaboration of the practitioners, the academic and cohorts of students.

Walsh, (2001) and Denscombe, (2010) claimed that there are further limitations to the AR methodology such as generally being appropriate for small-scale studies with 'local organisations'. Walsh went on to claim that AR researchers had difficulties with the:

> manipulation of variables, due to its iterative process, resulting in the limitation of the generalisability of the results and being ethically constrained [due to the fact it could] affect people's lives.
>
> (Walsh, 2001: 56)

The researcher agrees with Walsh (2001) that it would be difficult to generalise the findings from this investigation due to each end-user's diversity and spectrum of needs.

Tables 3.4:82 and 3.5:84 gives an explanation of Chart 3.1:85. It demonstrates how a cyclical Evaluation AR practice-based methodology had been used by the process and product in this investigation.

Table 3.4 An explanation of Chart 3.1:85 – How the cyclical action research methodology had been used for the process and product in this investigation (Plans stated in Chapter 4 Table 4.3:98)

Action Research Methodology	**Process**	**Product**
Observer/ Describe/ Planning (Think)	Chart 3.1- 1a:85: The researcher needs to continually carry out on-going discussions with practitioners in schools. She would need to repeatedly describe/plan the design/redesign of documentation: - Hierarchical Task Analysis (HTA). - Timescale. - Template profile. - Evaluation sheets, - Diary sheets, - Observation sheets, - Interview questions, - Questionnaires	Chart 3.1-1b:85: The researcher needs to design/redesign the Module and Assignment on an annual basis. This was achieved by repeated observing/planning/ describing/designing/ amending documentation e.g. Timescale/Feedback forms The researcher needs to give an explanation and help to cohorts of student's understanding of: - The module - The Assignment/ Coursework - The completed profiles - The previous students' games - The design and development of storyboards - The design and development of the computer games
Action (Act)	Chart 3.1-2a:85: The researcher needs to carry out pilot studies. She needs to continually submit documentation for practitioners to complete: - template profiles - storyboards + evaluation sheets - print outs + evaluation sheets - computer games + evaluation sheets - diaries - questionnaires, The researcher continuously needs to ensure receipt from practitioner's the completion of new + modified profiles and above documentation. She needs to carry out Interviews and Non-Participation Observations	Chart 3.1- 2b:85: The researcher needs to implement the Module and Assignment. -The researcher needs to ensure the distribution of completed profiles to students. - Provide students with examples of games - Give students advice and guidance on: - research - profiles - storyboards - games

Action Research Methodology	Process	Product
Testing/ Evaluation/ Modifying (Reflect)	Chart 3.1-3a:85: The researcher needs to: - reflect/test/modify documentation - analyse and evaluate storyboards and games. - analyse and evaluate the data from completed diaries, interview transcripts, questionnaires and non-participant observations - ensure receipt of new + modified completed profiles from practitioners The above (Chart 3.1- 1a-3a:85) is continuously repeated with the same or further schools over an extended period of time	Chart 3.1-3b:85: The researcher needs to: - ensure that students and their tutors, Reflect, Test, Evaluate and Modify the games before submission for grading. - herself further Reflect, Test, Evaluate and Modify each game before submission to schools. The above (Chart 3.1-1b-3b:85) is repeated with each cohort of students over many years.

Table 3.4:82 therefore gives an explanation of how Chart 3.1:85 was achieved through repeated collaboration with numerous schools and the design and development of cohorts of students (Appendix 1 Tables 4A-4D:260-265).

Chart 3.1:85 demonstrates how the evaluation AR practice-based methodology would be achieved by using continuous observing, describing and planning (Think) (Table 3.4:82), data collection, assessment, feedback, testing, evaluation (Action) (Table 3.4:82), modifying, monitoring and documenting (Reflect) (Table 3.4:82), throughout the process and the development of products for quality control (Powell, 2006). This would result in the analysis from quantitative and qualitative methods, leading to the dissemination to all participants in the investigation and publications. This would further enable the duplication process to improve the development of intervention and services for learners with ASD (Paulsen and Dailey 2002). Therefore, Table 3.5:84 gives an explanation of Chart 3.1:85 by reflecting on what will be learnt and thereby need to be rectified upon from the cyclical AR process and the products developed. This will be achieved with large groups of practitioners (users) having a continuous collaboration and input in the design, development and evaluation of repeated individualised therapeutic/educational products (computer games) developed by on-going cohorts of university students, for a large number of learners with ASD (end-users), over an extended period of time.

Table 3.5 An explanation of Chart 3.1:85 – What will be learnt from each stage of the AR process and product development.

Process	What should be learnt	Product	What should be learnt
Chart 3.1-1a:85 Approach and discussion with schools.	Chart 3.1-1a:85 The researcher should learn: - the practitioner's empathy for this project - if practitioners want to continue being involved. - If new schools want to be involved in the project.	Chart 3.1-1b:85 Design/amend Module and Assignment	Chart 3.1-1b:85 The researcher should learn the necessity for on-going modification of module and assignment.
Chart 3.1-1a:85 Plan, design/ amend documentation: - Hierarchical Task Analysis (HTA). - Timescale. - Template profile. - Evaluation sheets, - Diary sheets, - Observation sheets, - Interview questions, - Questionnaires	Chart 3.1-1a:85 The researcher should learn: - if necessity for amendments to any of the documentation. - that careful consideration needs to be taken to the timescale and the practitioners involvement in the investigation. This would be due to the university term-time differing from school's-terms.	Chart 3.1-1b:85 Plan, design/amend documentation: Timescale Feedback forms Plan and describe to students: - Assignment/ Coursework - Completed profiles - previous students' games - Storyboards -Games	Chart 3.1-1b:85 The researcher should learn: - the necessity to ensure that cohorts of students are given practitioner's feedback on the previous student's games to reflect upon. - the importance of encouraging students to evaluate and reflect on each other's games
Chart 3.1-2a:85 Carry out pilot studies. Submit documentation to practitioners: - template profiles - storyboards+ evaluation sheets - print outs + evaluation sheets - evaluation sheets for games - diaries - questionnaires, - completion of new + modified profiles Interviews and Non-Participant Observations	Chart 3.1-2a:85 The researcher should learn: - the need for further pilot studies. -if there was a continual need to carry out alteration to template profile. The researcher should learn the need to continually encourage practitioners in the evaluation of the games. - the necessity to continually encourage practitioners to fully complete the profiles.	Chart 3.1-2b:85 Implementation of Module and Assignment. - Distribution of completed profiles to students. - Provide students with examples of games. - Give students advice and guidance on: - research - profiles - storyboards - games	Chart 3.1-2b:85 The researcher should learn: -as to the success of the module and assignment/ coursework. - the need to develop further examples of games.

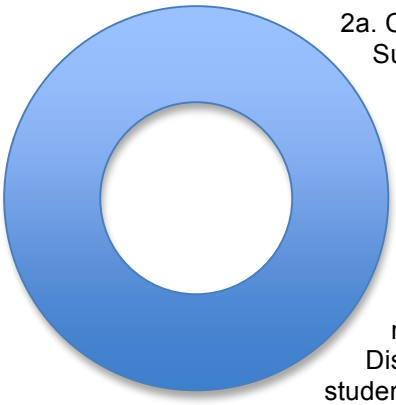
Process	What should be learnt	Product	What should be learnt
Chart 3.1-3a:85 Modification of documentation Analysis and evaluation of :… storyboards and tested games. Completed diaries Interviews Questionnaires Non-participant observations Receipt of new + modified completed profiles	Chart 3.13a:85 The researcher should learn: - that further modification of documentation may be necessary. - that practitioners may need to be encouraged in the completion of qualitative and quantitative methods as some may only be interested in just completing an initial evaluation of the games only. -to encourage practitioners to modify profiles and extended to new learners.	Chart 3.1-3b:85 Testing, evaluation and modification of games before submitting to schools.	Chart 3.1-3b:85 The researcher should learn: - the importance for cohorts of students and tutors testing, evaluation and modification of the games before submitting for grading. - the importance for her own on-going reflection, testing, evaluation and modification of each game before submission to schools.

Chart 3.1. The cyclical action research process used in this investigation

1a. Approach and discussions with practitioners in schools
Plan, design/amend documentation to practitioners.

1b. Design/Amend module and assignment.
Plan the development of the games with students.
(Observer/Describe/Planning (Think))

3a. Modification of documentation.
Analysis and evaluation of:.. storyboards, games., documentation and quantitative and qualitative methods



2a. Carry out pilot studies.
Submit documentation.
Receipt of completion of profiles and documentation.
Carry out interviews and non-participation observations.

3b. Receipt of modified and completed profiles.
Testing, evaluation modification of games before submitting to schools
(Testing/Evaluation/Modifying (Reflect))

2b. Implementation of module and assignment.
Distribution of profiles to students.
Provide students with examples of games.
Give students advice and guidance for the development of the games
(Action (Act))

The investigation, therefore, demonstrates through the repetition of Chart 3.1:85 how the cyclical use of AR methodology would be achieved through the on-going involvement and expansion of practitioners in schools and the continuous re-run of the module and assignment over many years. The investigation begins by piloting the process and an initial participation, input and evaluation from practitioners of one school. If the practitioners evaluated the individualised computer games as being of therapeutic/educational benefit/value for their learners and wanted to continue with the project, this would result in modification of the process and products. This could lead to the expansion to further educational establishments using a large group of participants over an extended period of time with further cohorts of students developing individualised computer games for learners with ASD. Modifications could be in the alteration of the profiles with a further explanation and examples given to the students for the development of the games.

3.6 Conclusion

The gaps and concerns from the literature review (Chapter 2:8)7together with the researchers own experience and expertise led to the development of the aim and objectives of this investigation. Furthermore, the researcher's ontological concepts directed her to the 'what' and 'how' research questions.

The researcher's general and professional knowledge (epistemological viewpoints) assisted in the justification of the appropriate chosen research methodology. The ontological (perspective) and the epistemological viewpoints demonstrated a multiplicity of interactions leading to the creation of understanding.

This was achieved 'between the whole [process] and the parts [design, development and evaluation]' dependent on each other through the collaboration of researcher and practitioner, practitioner and researcher; researcher and development team, development team and researcher (Brooks 2011:19).

Action research methodology and research methods were used to ascertain, from the cyclical maintenance of a Computerised Multimedia Therapeutic/ Educational Intervention (CMT/EI) process, if products developed would be of use to practitioners working with learners with Autism Spectrum Disorder (ASD). This could add to further future collaborative empirical action research by not only contributing to research knowledge but also impacting on society. The next chapter will give a full explanation as to a cyclical Computerised Multimedia Therapeutic/Educational Intervention (CMT/EI) process, which was adopted for this investigation (Figs. 4.1:91 and 4.2:92). It is the intention of this investigation to achieve this through an iterative collaborative holistic Design-For-One software development approach. This was presented by the researcher at the Recent advances in Assistive Technology and Engineering RASatE Conference at Coventry University (Stokes and Whitney, 2008). This process emerged from a university module and assignment originated by the researcher and resulted in the researcher's recent 2014 publications (Stokes, 2014a; Stokes, 2014b).

Chapter 4
Project Activity

4.1 Introduction and structure of the chapter

This chapter looks at how the project was constructed by breaking down the objectives based on the gaps and concerns from the literature review findings. This was to assist in answering the 'what' and 'how' research questions. The chapter explains how a, collaborative, cyclical, Design-For-One action research methodology had been adopted, for this practice-based investigation. It highlights the actors (participants) in this investigation. The chapter explains the ethical implications and how the process emerged from a university module and assignment. The chapter discusses how each learners' details and variance of needs had been acquired through practitioners' (users') completion of profiles on each end-user with an ASD. These were used as a baseline by cohorts of university students and academics (the development team) for the development of batches of individualised computer games. The games were evaluated by student's peers, tutors, the researcher and practitioners (mainly the teaching staff). The chapter explains the each cycle the Computer Multimedia Therapeutic/Educational Intervention (CMTEI) process went through. This consisted of the two stages (Stage I and Stage II) of two procedures (Initial Application and Prototype), which were piloted with an explanation as to what had been learnt from each cycle. The chapter ends with an explanation of the continuous monitoring, reflection and maintenance of the process through further batches of games.

4.2 Introduction to the Computerised Multimedia Therapeutic/ Educational Intervention (CMT/EI) process

The researcher discusses her roles as the researcher, HE teacher (Module leader/Lecturer) and project manager/designer (Lab tutor/Assignment/Learning Outcome) (Appendix 1 Table 4A:260). She further discusses the complexity of the project such as working with practitioners of different schools (the researcher's activity, interventions in schools, the different ways users engaged with the project and the end-user's participation (Appendix 1 Table 4B:262).

The researcher has demonstrated from the research (the knowledge being created through the project, the ways the project has contributed to changing perspectives or practice) and the layers of the product activity (as university teacher, the participants and potentially the wider field of practice) (Appendix 1 Table 4C: 264) (Zuber-Skerritt, 2002).

This investigation will be using the cyclical AR practice-based methodology (Table 3.4:82 and Chart 3.1:85) through the repetition of the process through the collaboration of numerous practitioners in schools.

Large groups of practitioners (users) will have input in the design, development and evaluation of individualised therapeutic/educational games (Table 3.4:82; Chart 3.1:85). These will be developed by on-going cohorts of university students for a large number of learners with ASD (end-users) over an extended period of time (Table 3.4:82; Chart 3.1(1b):85).

The study would be able to learn, reflect and modify this collaborative process and the development of individualised products (computer games) from the cyclical use of this AR methodology (Table 3.4:82). This would be achieved through piloting the process (Chart 3.1(2a):85) and the initial participation, input and evaluation from practitioners of one school (Chart 3.1(3a):85). If the practitioners evaluated the individualised computer games as being of therapeutic/educational benefit/value for their learners and wanted to continue with the project, this would result in modification of the process and products (Chart 3.1(3a):85). This could lead to an expansion to further educational establishments, using a large group of participants, over an extended period of time, with further cohorts of students developing individualised computer games for learners with ASD. Modifications would be in the alteration of the profiles, (further explanation with examples given to the students for the development of the games) and adjustments to the compiled documentation (evaluation sheets, diaries etc.) (Chart 3.1(3a):85).

The CMT/EI process comprises of two stages (Stages I **-** Planning, collection, organisation and design and development) (Fig.4.1:91) and Stage II – Testing, Evaluation, Monitoring, Reflection and Maintenance) (Fig. 4.3:95). In the following diagrams, Figs. 4.1:91; 4.2:92 and Table 4.3:95 the adaption of the process to action research is demonstrated…

Fig. 4.1:91 - Stage I
Fig. 4.2:92 - Stage II
Fig. 4.3:95 - Design-For-One Approach (Multimedia Elements in the Development of the Games)
Table 4.3:98 - Hierarchical Tasks Analysis

*A brief explanation of Stage I **-** Planning, collection, organisation and action (Fig. 4.1:91)*

Engagement with Schools. The schools approached to participate in this investigation were Special schools across the United Kingdom (Scotland, Hertfordshire, Cambridgeshire, London), working with 49 practitioners (Teachers, SALTs, Teaching staff, a Deputy Head of Autism/ICT Coordinator, an ICT Coordinator, a Deputy Head Teacher and an Assistant Psychologist) (users).

The nature of the research was explained to the school's staff using a formal meeting. During this meeting, their agreement to participate was gained and they were introduced to the blank profiles (developed by the researcher), which they were asked to complete (Chart 3.1 -1a and 2b:85; Fig. 4.1A:91).

Engagement of students to design software. The completed new and/or modified profiles of the users were randomly distributed to the development team (i.e. the students on the module). The students had been taught the meaning of each criteria on the profiles so they would be able to research, plan and develop the storyboards for the games, which were appropriate for each end-users' individual profiles (Chart 3.1-1b and 2b:85; Fig. 4.2B:92).

Fig. 4.1 Stage I (Planning, collection, organisation and action) of the CMT/EI (Initial Application + Prototype) procedures

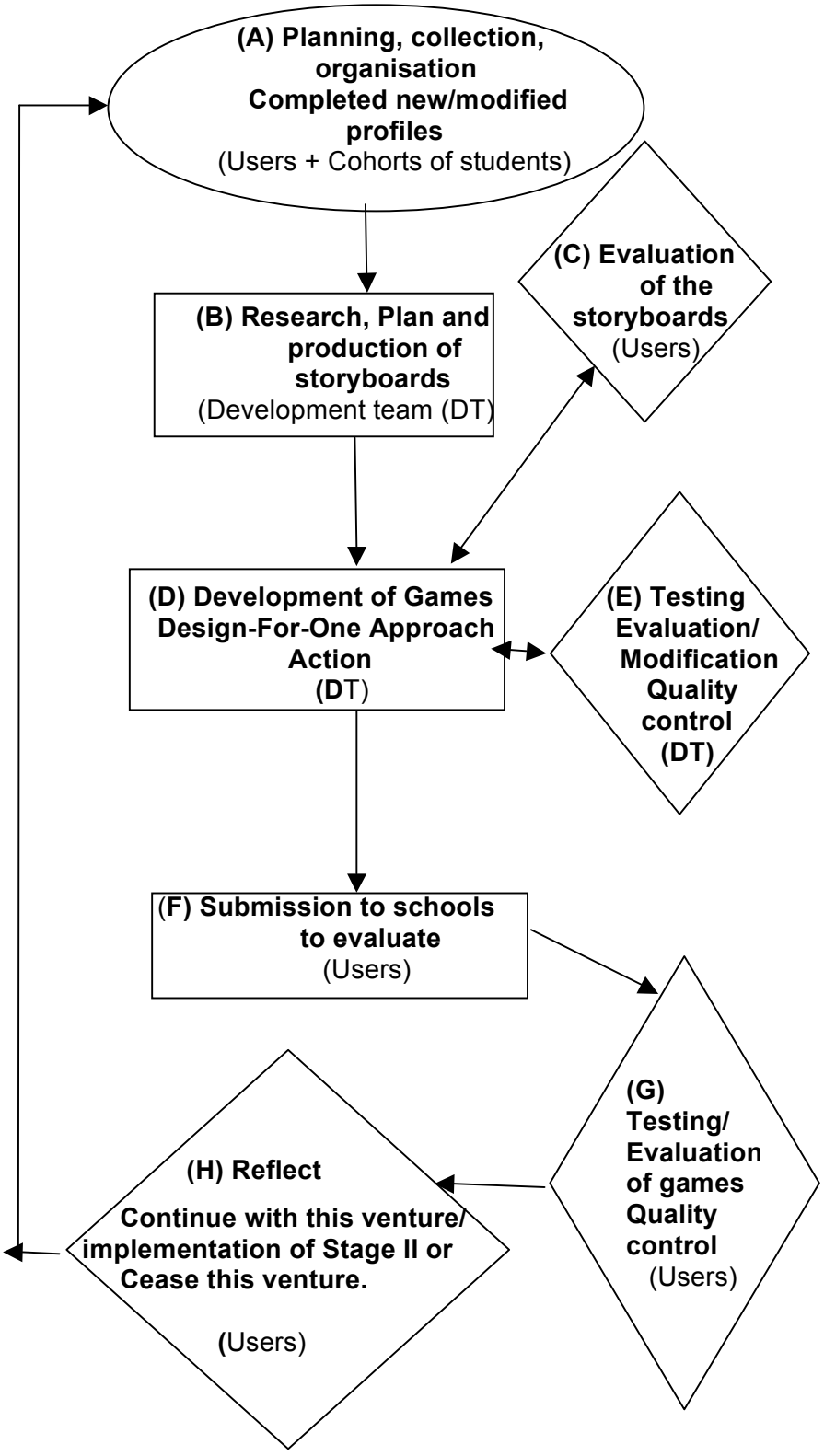
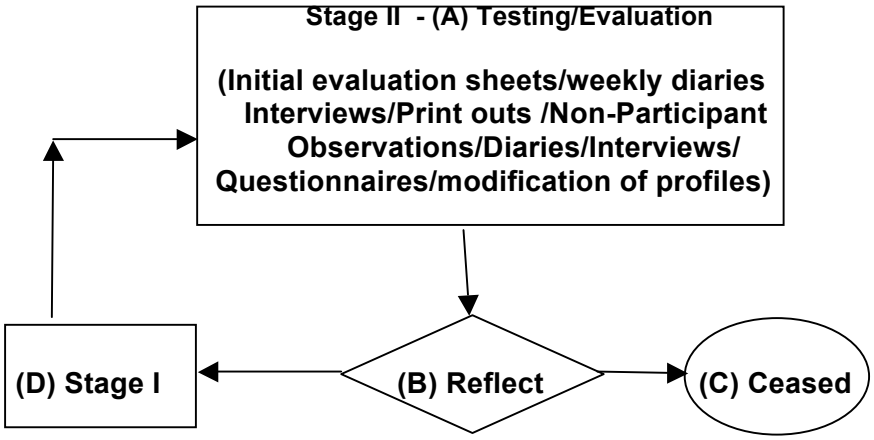


Fig. 4.2 Stage II (Testing, Evaluation, Monitoring, Maintenance and Reflection) of the CMT/EI (Initial Application + Prototype) process



Evaluation of storyboards. The researcher submitted the completed storyboards to the school/s for the users to evaluate. The feedback from the users on the storyboards were then shared with the students so that appropriate amendments could be made to the games being developed *(*Fig. 4.1B and C:91).

The production of the games. The "doing" part (Action) of the research was the actual production of the games using a Design-For-One Approach. The students were supervised in the incorporation of the appropriate multimedia elements into the computer games) (Chart 3.1 - 2b:85; Table 4.3:98; Fig 4.1D-H:91).

The testing of the software by students. The development team then tested and evaluated each other's games (Fig. 4.1E:91 - Testing, Evaluation and Modification) leading to further modifications (Fig. 4.1D:91) before submission to schools (Chart 3.1 -3b:85; Fig. 4.1F:91).

Practitioner evaluation of the games. Practitioners (users) would evaluate each game to decide and choose whether any of the games would be of therapeutic/educational use for them and their end-users (Chart 3.1-3a:85).

Review and reflection. Practitioners (users) then reflected on whether these and further games developed through this process would be useful to them (users) and their end-users (learners). They also identified whether the practitioners in the school would continue with the implementation in the classroom (Chart 3.1-3a:85).

Users then had the opportunity of implementing the use of the games in the classroom and continuing to Stage II (Fig. 4.2:92) and/or to repeat Stage I (Fig. 4.2:92) with new and/or modified profiles or to cease further collaboration on this venture (Fig. 4.2:92).

Stage II – Testing, Evaluation, Monitoring, Reflection and Maintenance (Fig. 4.3:95).

User Evaluation of games. Testing/Evaluation was carried out by the users using both quantitative and qualitative methods. These were initial evaluation sheets, diaries, interviews, print outs, non-participant observations and questionnaires. This data was analysed as identified in the subsequent chapters (Chart 3.1-3a:85).

Piloting - The process was piloted with users and end-users from one school (School L) and the first development team (academics and university students) (Chart 3.1-2a:85). Before this could be started the researcher investigated potential design guidelines, frameworks, principles (heuristics), design objectives, processes and approaches that could be used to develop the software (Table 4.1:94).

4.3 Design and Development

User Centred Design (UCD) method of putting the user (i.e. the learner) in the centre of the investigation was adapted for this research. Although practitioners were completing profiles on their end-users, they were doing the initial review of the individualised games developed for their end-users.

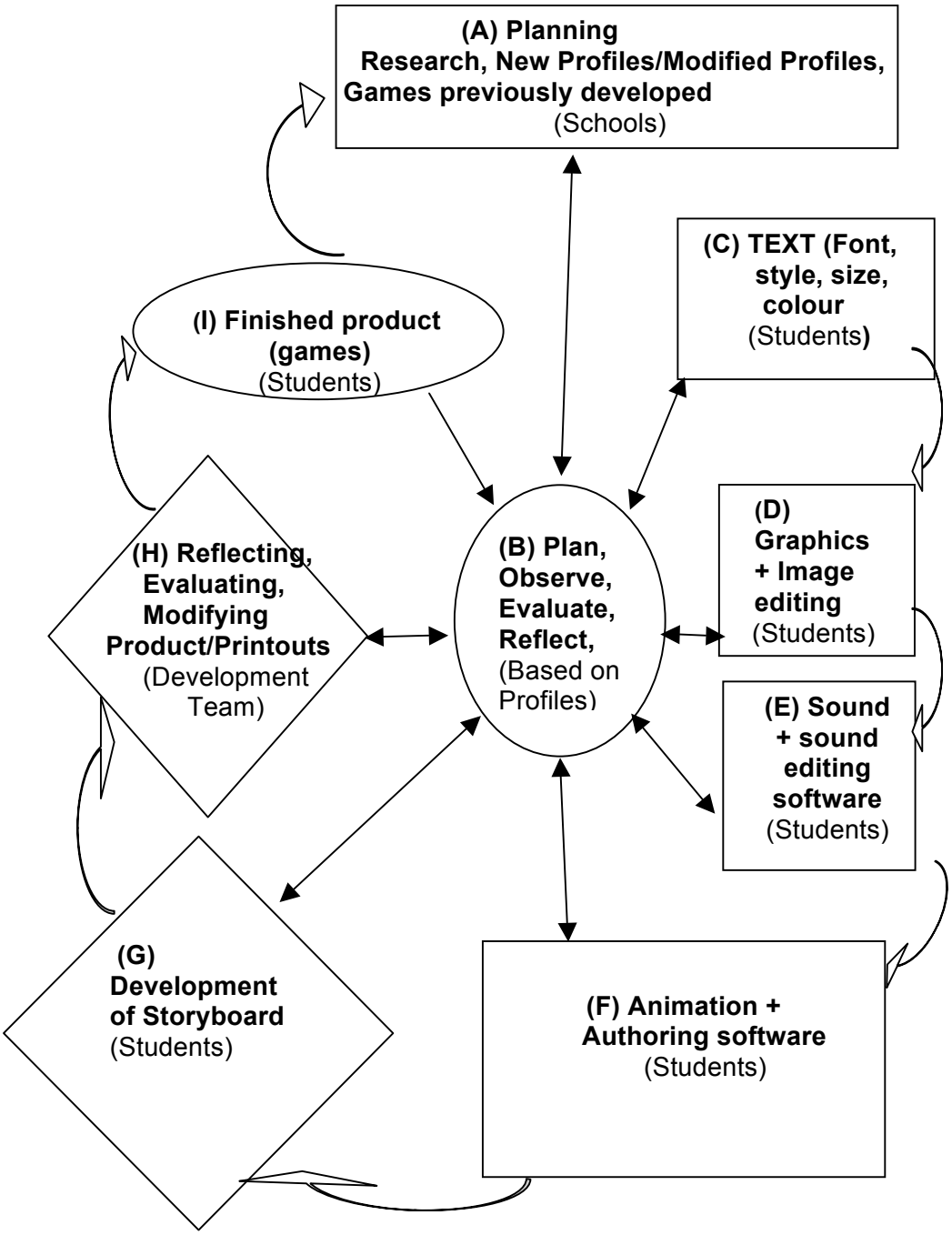
Table 4.1 Design guidelines, principles (heuristics), processes and approaches.

Design guidelines, principles (heuristics), processes and approaches	Adopted for this investigation
CAL	Effective ways to use technology to inspire and aid each end-user with autism (The National Autistic Society, 2004a)
SPELL	Meeting the communication needs of each end-user though the continuity and order in their lives (The National Autistic Society, 2004a, 2004b).
ETSI	Taking into consideration each end-user's abilities, needs and requirements and putting the end-users at the centre (ETSI, 2010)
Jordan's Instructional Approach	Addressing the difficulties while devising learning interventions, environments, treatment and teaching plans (Jordan, 2013)
BECTA	ICT for Learning and Teaching, Disability and Legislation: Guidance for Commissioners and Suppliers', Terminology for Accessibility and Assistive Technology and Standards and guidelines for making accessible software. (Dix, et al. 2004; BECTA 2007a, 2007b)
Heuristics Design Principles	Software design issues. This investigation adopted a Hierarchical Task Analysis (HTA) (Table 4.3:98) a method to carefully plan events (Dix, et al. 2004; Stanton, et al. 2014).
Human Computer Interaction (HCI)	Dix, et al. (2004: 253; Dong, et al, 2012) stated, HCI approaches …involve…design, implementation and evaluation of interactive system…
The spiral and star process	The iterative evaluation stages of the software design development (Pagliari, 2007; Antunes, et al. 2012).

This would enable the users to evaluate the games therapeutic/educational use and allowed them to decide whether the games should be implemented in the classroom (Benyon et at. 2005; Barry and Pitt, 2006, Reported by Stokes, 2008b) using an initial evaluation sheet developed for the project.

The emphasis of the project is on the diverse needs of the end-users in this study, this led to adopting a User Centred Design (UCD) approach which was adapted to a more specific individualistic tailored holistic autistic centred Design-For-One approach (Reported by Stokes, 2008b).

Fig. 4.3 Design-For-One Approach



At the time of writing up this investigation the literature review findings had not established any standards and/or guidelines for designing, developing and evaluating individualised tailored therapeutic/educational games specifically for users supporting end-users with ASD.

Nevertheless, consideration has been given to standards, guidelines and design principals (heuristics), processes and approaches (Table 4.1:94) that have been devised, from theory and practice.

In past research, there was a lack of recorded evidence of studies, involving the users' expertise on the autistic end-users' spectrum of needs and interests. The diversity of each end-users with ASD needs, preferences and interests were taken into consideration in this investigation.

This practice-based action research CMT/EI process will use a Hierarchical Task Analysis (HTA) and Human Computer Interaction (HCI) approaches through an iterative collaborative software Design-For-One approach for the development of individualised therapeutic/educational computer games. (Fig. 4.3:95). This was discussed by the researcher at conferences, in conference papers and journal articles (Reported by Stokes, 2003c, 2008a, .2008b; Stokes and Whitney, 2008).

4.4 Design-For-One Approach

Professor Jönsson (2006) edited a book entitled Design Side by Side. It has chapters written by ten authors who work at Certec in the Department of Design Sciences at Lund University's Faculty of Engineering. One of the authors Breidegard (2006) wrote in Chapter nine 'Emma and the Minimeter" about how he individually designed an effective family photograph software album specifically for a non-verbal girl with communication difficulties and only able to move one of her little fingers, her head and eyebrows. This girl, however, was not on the autistic spectrum and he had not demonstrated that he had gathered data as to the girl's needs, her modalities and multimedia preferences, likes, dislikes, strengths, weaknesses and interests from practitioners and parents.

Although it was effective with this one end-user, it had not been designed, developed and evaluated as being effective for others over an extended period of time. This investigation will be using a Design-For-One approach for designing and developing therapeutic/educational computer games for end-user's with ASD, the diversity of their needs, preferences, interests will be ascertained through the collaboration of the practitioners over an extended period of time.

Jönsson (2006) explained in Chapter 11 'Rehabilitation technology, design and pedagogy' as to the importance of working with individuals from the beginning to the end of the development process. This was to ascertain from them their perceptions, what is important to them, what they want to do, their needs, memory preferences, personality and future dreams from the doing and acting in the classroom situation which Jönsson claimed is difficult to establish through questionnaire and interview methods. This was, however, achieved through this practice-based action research investigation through the collaboration with users, as the end-users with ASD in this investigation were unable to communicate their therapeutic and educational needs. Their diversity of needs meant it was not feasible to work with these individuals.

Furthermore, it would be the practitioners in schools who would be implementing the computer games in the classroom. It was important to collaborate with practitioners, using their expertise and knowledge on each of these learners' perceptions, preferences and what they would consider to be of therapeutic/educational benefit/value for their learners needs. The investigation also used diaries, non-participant observations and evaluation of storyboards and the individualised computer games, by the practitioners. This thereby, achieved through the doing and the acting in the situation (in the classroom in academia and in schools) in this practice-based action research investigation.

The AR cycles/stages and schools

The AR cycles/stages and schools used in the CMT/EI process, was carried out through the use of a Design-For-One approach (Table 4.2:97).

Table 4.2 Cycles/Stages and Schools used for the CMT/EI process

Process	**Cycles/Stages**	**Schools**
Pilot of the Process	Cycle 1 -Stage I	School L
Initial Application	Cycle 2 -Stages I and II	School L
Pilot of the Prototype	Cycle 3 -Stages I and II	Schools R, W, C
Prototype	Cycle 4 -Stage I and II	Schools F, CC, H/C, N and S

Table 4.3 Hierarchical Task Analysis (HTA)

Plan 0– Computerised Multimedia Therapeutic/Educational Intervention (CMT/EI) process

Plan 1 Literature Review (Chapter 2:8)

1.2 Search and read books/journals onsite and offsite plus databases on topic *

Plan 2 Methodology (Chapter 3:64)

2.1 Action Research (Chart 3.1:85) *

Stage I Pilot and Initial Application and Prototype

Plan 3 Plan/Develop – New/modified Profiles (Chapter 4) (Fig. 4.1 A:91, Table 3.4:82)

3.1 Approach schools *
3.2 Production/modification of the templates of the profiles *
3.3 Submit blank template profiles to users to complete/modified*
3.4 Completed/modified profiles forms returned **
3.5 Distributed completed/modified profiles to students *
3.6 Show students previous games*

Plan 4 Research, Plan, Production and Evaluation of Storyboards (Chart 3.1:85; Fig. 4.1B, C and G:91; Table 3.4:82)

4.1 Students produce report ***
4.2 Production of Storyboard based on research findings + profile *** (Plan 3,3.5)
4.3 Submission of storyboard to user *
4.4 Evaluation and feedback of storyboard ** (Repeat 4.2)

Plan 5 Design-For-One approach (Development of the Games* (Chart 3.1:85; Fig. 4.1 C- F:91)**

5.1 Each end-users' details (age, gender, ethnic origin and first name) from profile considered.
5.2 Each end-users' medical problems, autistic needs, learning and behavioural difficulties considered.
5.3 Each end-users' therapeutic and educational needs considered
5.4 Each end-users' computing (modality and multimedia elements preferences) abilities considered
5.5 End-users' likes, dislikes, strengths, weaknesses, interests considered
5.6 Amendments based on evaluation and feedback by users on the storyboard (Repeat 5.1-5.5)
5.7 Development of games

Plan 6 Reflection, evaluation, modification, storage and submission (Chart 3.1:85; Fig. 4.1G:91) ***

6.1 Evaluation of games by development team
6.2 Modification of games (Repeat Plan 5)***
6.3 Evaluation of games by the researcher*
6.4 Modification of games (Repeat Plan 5)*
6.5 Storage of games on individual CDs *
6.6 Production of print outs and evaluation sheets***
6.7 Submission of CDs with print outs and evaluation sheets to Schools (Fig. 4.2F:92) *

Plan 7 Testing, evaluating and reflecting on the games, by users (Chart 3.1:85; Fig. 4.1G:91) **

7.1 Project ceased (Fig. 4.1H:91) or Plans1-7 0Stage I repeated (Fig. 4.2A:92 and/or Stage II Fig. 4.1 I:91) Plan 8

Stage II Pilot and Initial Application and Prototype Implementation, Evaluation, Testing, Maintenance, Publication (Chart 3.1:85; Fig. 4.2 A,I:92 and Fig. 4.2:92)

Plan 8 Reflection/Evaluation/Modification of print outs – (Quality Control) (Chart 3.1:85; Fig. 4.2 A, E:92)

8,1 Users evaluating the games **

Plan 9 Implementation

9.1 Choosing and implementation of the most appropriate therapeutic/ educational game for each of their end-users (Fig. 4.2G:92;Fig. 4.3:95)**

Plan 10 Initial evaluation of games

10.1 The completion of Initial evaluation sheet **

10.2 Returned completion of Initial evaluation sheet, based on the evaluation of the games **

10.3 Reflection and Analysis of the feedback from the completed Initial evaluation sheets and print outs *

Plan 11 Pilot Diaries (Users)

11.1 Development of pilot diaries *

11.2 Submission of pilot diaries*

11.3 Users completing pilot diaries whilst end-users were using the games**

11.4 Returning completed pilot diaries **

11.5 Analysis of diaries *

Plan 12 Non-participant observation technique

12.1 Planning for observations *

12.2 Non-participant observations carried out with users and end-users operating the games *

12.3 Analysis of observations *

Plan 13 Telephone Interviews

13.1 Planning of telephone interview *

13.2 Telephone Interview carried out with user *

13.3 Transcription of Telephone interview *

13.4 Send transcription of telephone interview to user*

13.5 Verification of transcription of Telephone interview **

13.6 Analysis of Telephone Interview *

Plan 14 Diaries

14.1 Development of diaries *

14.2 Submission of diaries to schools *

14.3 User completes diaries whilst end-users used games **

14.4 Completed pilot diaries returned **

14.5 Analysis of diaries *

Plan 15 Semi Structured Interviews

15.1 Development of Interview *

15.2 Interviews with users *

15.3 Transcription of interviews *

15.4 Transcription of interviews sent to users *

15.5 Verification of transcription of interviews returned **

15.6 Analysis of interviews *

Plan 16 Questionnaires

16.1 Production of questionnaires *

16.2 Questionnaires sent to users *

16.3 Questionnaires completed by users whilst end-users were using games**

16.4 Completed questionnaires returned **

16.5 Analysis of questionnaires *

Plan 17 Reflection (Fig. 4.2:92) on the findings

17. 1 Submission for publications *

17.2 Project Ceased (Fig. 4.1 H:91, 4.3:95) or Plans 1- 7 Stage I repeated (Fig. 4.2A:92,4.3:95)and/or Plans 8 -17 Stage II (Fig. 4.1I:91)

Key to HTA * carried out by researcher of this thesis + could be carried out by future researchers/development teams.

** carried out by users in this investigation + could be carried out by future users.

*** carried out by the development team in this investigation + could be carried out by future researchers/development team

This investigation began with Semester 1 (September – January) and consisted of large cohorts (approximately 150) of university students e.g. a group of students, from different classes, working on each of the 27 end-users' profiles, which had been completed by users (practitioners) from School L. *(*AR Cycle 1 – Pilot of Initial Application).

Semester 2 (February – June) consisted of a small cohort of approximately 50 students, from two classes, e.g. working on each of the 27 end-user's profiles (Initial Application procedure) (AR Cycle 2 – Initial Application*).* This then resulted in a Pilot of the Prototype procedure, using three schools (Schools C, R and W) (AR Cycle 3 Pilot of Prototype).

This was followed by a Prototype procedure (Table 4.3:98) using further schools also undergoing 4 cycles – Stage I and II (Figs. 4.1:91, 4.2:92 and 4.3:95) and indicated in the Hierarchical Task Analysis (HTA), (Table. 4.3:98) (AR Cycle 4 – Prototype). A HTA was used to ensure that all the tasks applicable to each stage were sub-divided throughout the whole process (Figs. 4.2:92, 4.3:95; Table. 4.3:98).

The AR cyclical development of games

The researcher randomly distributed completed profiles to cohorts of students. Each student received a profile of a real end-user. The researcher guided them in carrying out their tasks for the game development. This included discussing with students the user's feedback on previous individualised games, which had been developed.

Throughout, the researcher guided students on carrying out research with an analysis on new/modified profiles (Fig. 4.1B:91) and/or previously developed games. The researcher also identified to the class tutor and students (the development team) the need to incorporate the appropriate text, graphics, sound, animation (Fig. 4.1B,C-F:91) in relation to the profiles. This was achieved with the students being taught image manipulation, sound editing and authoring software (Fig. 4.2B, D-F:92).

The researcher assisted students in matching the end-users' profiles to the production of storyboards (Fig. 4.1G:91). Evaluated feedback from practitioners, on previous cohort's student work (storyboards/ games) were disseminated to the students (Fig. 4.1H:91). The researcher guided students with the production of appropriate fun therapeutic/educational games (Fig. 4.2B:92) and print outs. These were evaluated by the development team and researcher prior to submission to schools.

4.5 Actors in the Research

The actors (participants) in this investigation were 464 learners on the autistic spectrum (end-users) and 49 practitioners (users) consisting of Teachers, SALTs, Teaching staff, a Deputy Head of Autism/ICT Coordinator, an ICT Coordinator, a Deputy Head Teacher and an Assistant Psychologist from eight schools, (Table 4.4:107) the researcher and cohorts (over 2,000) of university academics and students (The Development Team).

The development team

The computing science development team consisted of the researcher, as module leader, supervising a development team of multimedia/computing science academics, lecturers, seminar and lab tutors and first year undergraduate students studying on a multimedia module (Reported by Stokes, 2006a; 2006b; 2007).

This research was part of an assignment for the multimedia module of the student's degree programme where the students attended weekly theoretical multimedia lectures on software development.

The tutors (led by the researcher – also a tutor) would teach the students practical research and multimedia skills in weekly laboratory classes. These would cover the use of imaging editors, digital sound technology and an authoring tool. The module leader/lecturer (the researcher) had overall leadership of the students in developing appropriate, specialised, individual, therapeutic and educational multimedia games after carrying out their research (Reported by Stokes, 2014a; 2014b).

4.6 AR Cycle 1 – Pilot of Initial Application

Schools

The investigation began by choosing a special school in one particular LEA area (School L) with a population of appropriate end-users (Beins, 2012). The school was chosen from The National Autistic Society's (2000) Schools, Units and Classes booklet. The head-teacher in School L was approached by telephone and it was explained that their users could be participating in collaboration with this investigation.

Explanation would be given to practitioners as to how university undergraduates would be developing individualistic therapeutic/educational multimedia games (products), as their assignment, for practitioners and learners. Practitioners in the school enthusiastically welcomed the project. It became apparent that a good rapport and working relationship with the school staff needed to be acquired for the research to progress. Users were allowed to use their own judgment to choose end-users who would benefit from individualised computer games and complete their profiles. Having evaluated the therapeutic/educational potential use of the games, they substantially increased the number of participating end-users and submitted modified and completed new profiles to enable the development of additional individualised games.

The rationale for using so many schools was firstly due to further practitioners in schools requesting to be part of this project. This was due to having heard the success of the process and products by word-of-mouth and demonstrates the iterative process and maintenance of the project.

Secondly, the investigation enabled as many schools (Appendix 1 Table 4D:265), users and end-users as possible to benefit from having individualised therapeutic/educational fun computerised games developed for them.

Thirdly, to demonstrate the maintenance of the process, the researcher was fortunate enough to have annual cohorts of students studying the module and carrying out the assignment proving to be a success from the positive feedback from students (Appendix 2:268).

This chapter will explain how some of the other practitioners participating in this investigation preferred to have the same end-users keep receiving supplementary games, which were developed for their end-users. The chapter discusses the ethical issues with the involvement of students and schools

4.7 Ethics

The users were fully informed of the purpose, methods, risks and intention of the research and were given the rights to participate or withdraw at any time during the investigation (Bowling, 2006, 2014; Boxwell and Ralph, 2009). A small group of six end-users from School L were chosen by the users from their school population. There were no indications as to whether these particular end-users were randomly or specifically chosen by the users. If the sample of end-users had been chosen or known to the researcher, this could have biased and invalidated the study due to already known expectations. These end-users were equally not deliberately chosen by the researcher, this gave this investigation had unbiased perception. The study endeavoured to keep the random sample of the specific school population anonymous in this investigation. This was discussed in the researchers numerous published and unpublished work from 2004-2014.

Permission letters (and later a follow up letter) were sent to schools for modification and distribution to the appropriate parent/guardian of the end-users (Appendix 3:269). This was to gain, without coercion, the validity of freely and voluntary consent. The practitioners retained the signed and granted permission slips, which ensured the confidentiality and anonymity of all participants (Blumberg, et al. 2005; Bell, 2014). The consent given by the parents enabled the users to complete each end-user's individual profile incorporating their age, disability, race, ethnicity, gender or other characteristics.

The researcher collaborated directly with the users throughout this investigation and not with the end-users. The products were being developed for the users' utilisation, based on the qualitative information relating to each end-user from their completed profiles (Chart 3-1a:83). The use of the profiles were discussed in the researcher's (Stokes, 2008a) article in the International Journal of Disability and Human Development.

The users were reassured that numbers and letters would be used for each end-user to keep their anonymity and confidentiality. The only person who knew which end-user belonged to the appropriate profiles was the users involved in this investigation. The products were developed on a continuous collaborative basis. The users evaluated and chose the most appropriate therapeutic and/or educational game developed for each individual, prior to its implementation and use in the classroom by the end user.

By ensuring confidentiality (Cohen, et al. 2000, 2011; Bell, 2014) and anonymity, an elimination of bias (Kahneman et al. 2011) helped to alleviate scepticism from the reliance on data not just from the literature review (Institute for Work based Learning, 2012). There were also no major ethical issues, conflict of interests, risks and/or cause for potential harm or offence to any of the participants in this investigation. Furthermore, the research was conducted in a moral and responsible way with the rights of all the participants involved safeguarded from harm, dignity, discomfort, pain or embarrassment by informed consent, honesty, integrity, secrecy, truthfulness, legality, privacy and professionalism (Blumberg, et al. 2005; Alderson and Morrow; 2011; Beins, 2012*).* To overcome invalidity and unreliability the investigation was carried out in naturalistic therapeutic and educational environments (Pelham, et al. 2011) through repetition, expansion and maintenance. The continuous collaboration with all the participants throughout the systematic process ensured the reliability and validity of the process and product (Bowling, 2006, 2014; Schmutz and Manser, 2013). A signed ethical letter from the university is included (Appendix 4:270).

It was, however, important to encourage the users (practitioners) whom were knowledgeable about the end-users (learners), to participate as collaborators. Walsh (2001) regarded this as being:

> positive and ethical, because it gives the [users of the] researched [end-users] an important role and voice in the research process…
>
> (Walsh, 2001:56)

The module and assignment were designed, reviewed and undertaken to ensure honesty, integrity, confidentiality and anonymity for all the students involved. The students were also fully informed of the purpose, methods, risks and intention of the research. The students were given the right to participate or withdraw from the research by undergoing an alternative assignment (Bowling, 2006, 2014; Boxwell and Ralph, 2009). This was to gain the validity of freely and voluntary consent, without coercion.

As a parent of a learner with disabilities, the lecturer/researcher was able to ensure students were aware of the sensitive nature of this investigation. Students were also made aware of risks and safeguarding issues in relation to harm, dignity, discomfort, pain, embarrassment, anonymity, confidentiality, truthfulness, legality, privacy and professionalism in relation to the development of their products for each end user (Blumberg, et al. 2005; Tsiris et al, 2014*).* Students were strongly instructed to only use photos, images, animation and sound, which they owned. They had to take their own photos and record they own sound. The researcher acquired copyright clearance for the use of images from CBeebies, Disney and Thomas-the-Tank Engine, Makaton Sign language symbols and ColdPlay music and lyrics from the band themselves for the students to use in their games appropriately. Equally ethical issues relating to the students themselves were considered in relation to keeping their anonymity and confidentiality e.g. name, student number, age, disability, race, ethnicity and gender. The researcher agrees with Walsh (2001) that it would be difficult to generalise the findings of this investigation, due to each end-user's diversity and spectrum of needs and the iterative process.

The ethical risks were further reduced by the researcher not being a user in this investigation and thereby, being detached and impartial. Whereas, the researcher's role, as an academic enabled her to accept her responsibility, ownership, leadership and the consequences of this substantial study with the involvement of so many schools.

There were, therefore, no major ethical issues, prolonged or repetitive testing, sensitive topics, sexual activity, drugs, placebos, invasive intrusive interventions, blood or tissue samples or cause any discomfort, psychological stress, anxiety or humiliation 'beyond the risks encountered in normal life' (ESRC, 2010: 25). Using schools in this investigation was appropriate for this chosen AR methodology. With the users' involvement from the beginning, a good mutual rapport was achieved by a collaboration and continuous contact. This was typical of an AR approach with this iterative process for improving and building upon experiences. To answer the research questions, using Action Research Methodology the following methods were used beginning with the development of blank profiles used as a baseline for the development of individual games.

4.8 Methods employed in this study

The construction of the profile

The areas of the template profile for the users to complete were: age, gender, learning difficulties, medical conditions, communication, computing ability, reading level, comprehension level, software enjoyed, software to be used by individual only or with assistance, educational area to develop, any additional comments (Reported by Stokes, 2008a 2014a, 2014b). The areas chosen were identified from the literature review as previously cited. It was necessary to gather data on each end-users' therapeutic/educational individual details and needs (Chapter 2:8). This template profile was adjusted several times (Chapter 5:129) with the action research cyclical approach used in this study. The completed profiles would be used as a baseline in order to apply a holistic Design-For-One approach for developing customised fun games for each end-user.

Schools completion of the profiles

Practitioners in schools were approached to participate in this research. If they agreed, a permission letter was designed by the researcher and sent to the schools to distribute to parents, with the return slips retained by the schools staff. To reiterate, to keep confidentiality and protect the anonymity each school throughout the process were referred to by a letter and each end-user by a unique identifier (number).

The users chose end-users with no indication as to the reason for their choice. The users participating in the investigation from each school returned their completed (new or modified) profiles. This area was discussed by the researcher in the Advances in Automation, Multimedia and Video Systems and Modern Computing Science 2001 conference in Malta and a book publication (Stokes et al. 2001).

*The Development Team's use of the profile*s

The Design-For-One approach began with the completion of profiles (Reported by Stokes, 2008a) on a sample end-users from School L. These were randomly and anonymously distributed to the development team consisting of a new cohort of computing science university students and academic multimedia team of tutors. Students were advised and made fully aware of the importance of their participatory role in an assignment for research purposes, being part of a development team, using their research and practical knowledge and creative multimedia skills to make a valuable contribution to society (Reported by Stokes, 2007). The students' awareness of autism and other disabilities gained through their research findings were heightened by theoretical lectures. This has been discussed in the researcher's publications (Stokes, 2006a, 2007). The information outlined in the completely anonymous profiles were then used by the development team to develop individualised tailored multimedia games for each of the end-users, based on the qualitative information stated in their profile. Users and end-users would receive a selection of games, which were developed from the profiles (Reported by Stokes, 2006a, 2007, 2008a, 2014a-2014b).

4.9 Project Activity

Practitioners in schools were approached informing them on the investigation and submitting a questionnaire consisting of a limited number of questions (Table 4.4:107).

Table 4.4 Dates, stages and process

Dates	Stages	Process
September-December 2002	Main Study	Contacting schools Questionnaires

This was to consider if software (computer games) were being used in schools and to attain the users' evaluation of the games. (These were posted out to random special schools (in one LEA) in September 2002. (Reported by Stokes, 2003a, 2003b, 2003c, 2003e). Only practitioners from one school completed the questionnaire and returned it via the postal system. Questionnaires were then submitted electronically, but again, there was no response. Emails were submitted to a few schools requesting a meeting with the staff to discuss the research, but again this was not successful (Bowling, 2006, 2014; Harris and Brown, 2010). An attempt was then made using a simple telephone structured questionnaire. This produced excuses and disinterested responses, such as the staff were tied up in meetings, requests for the questionnaire to be submitted electronically, suggesting a call back or offering to take the telephone number and they would return the call shortly, but failing to do so. Perhaps they were treating this as being a "cold caller" situation. It demonstrated the weaknesses and inadequacies of using just traditional methodological techniques (Harris and Brown, 2010). These difficulties were potentially problematical due to the schools' staff seeing the interviewer as an outsider. The negative responses could also have been due to a lack of understanding, interest, time, involvement or staff thinking involvement would increase their workload and with them not being in control of this investigation. They may have felt threatened by what they regarded as the ill-informed, inexperienced, intrusive interviewer and possibly felt apprehensive of giving up their time and hard work for just the researcher's gain (Bowling, 2006, 2014). The obstacles arising from traditional research methods resulted in alternative approaches being sourced. The collection and organisation stage of the iterative AR approach (University of Wollongong, 2001) was adopted by this investigation. It was important to trial the prototype procedure with a sample school and is referred to as the 'initial application' procedure (Table 4.5:108).

Table 4.5 The collection and organisation of the Pilot of Stage I of the process – 1st AR cycle

Dates	Stages	Process
January- February 2003	Pilot of Stage I – Initial Application	Profiles Planning/Action

To get practitioners involved in the project it was important to emphasise that the computer games would be developed based on what they stated on the profile and they would be able to evaluate the games and choose the games they considered would be of therapeutic/educational benefit and value.

Action Stage–Interpretation of Data, Design and Development of the 1st batch of games (from the 1st AR cycle)

The action stage consisted of the stages the process went through e.g. the action, which took place, and the timescale involved for the design and the development of the games carried out in the pilot of Stage I and Stage I of the Initial Application prototype procedures (Tables 4.6:109 and 4.8:111).

Table 4.6 Stages, Actions and Dates of the pilot (1st AR cycle) of the initial application (Figs. 4.1:91 and 4.2:92)

Stages of the pilot (1st AR Cycle) of the initial application CMT/EI process (Figs. 4.1:91 and 4.2:92)	**Action**	**Date carried out**
Main Study	Research, Plan and developing **(Observe and Describe)**	September 2002
Pilot Stage I	Blank template of profile for school to complete **(Plan)**	January-February 2003
Pilot Stage I	Developed 1st batch of games) Large cohort (200) **(Action)**	February-June 2003
Pilot Stage I	Evaluation of games-not carried out 1st batch) **(Reflection Evaluate and Modify)**	June-September, 2003

To develop the games for the CMT/EI process (Figs. 4.1:91; 4.2:92; 4.3:95; Appendix 1 D: 265) it was important to plan the dates, stages and process of the initial application (Table 4.7:110). This began with the planning of the storyboards.

Table 4.7 Dates, Stages and Process of Initial Application and AR cycles (Figs. 4.1:91 and 4.2:92)

Dates	Stages	Process
January – June 2003 Semester 2	Pilot of Stage I Initial Application	Development of 1st batch of games Action (1st AR Cycle) (McNiff, 2013)
August 2003	Pilot of Stage I of Initial Application	Without evaluation (1st AR Cycle)
September-January 2004 Semester 1	Stage I of Initial Application	Profiles used (not modified) Development of 2nd batch of games/ 2nd AR cycle (small cohort of students) Planning/Action/Reflect/E valuate/ Modify (McNiff 2013)
January – June 2004 Semester 2	Stage I of Initial Application and Pilot Prototype	Non-modified profiles Development of 3rd batch of games 3rd AR Cycle 1) Planning/Action (McNiff 2013)
September 2004 – January 2005 Semester 1	Stage I of Initial Application and Prototype of the CMT/EI process (Figs. 4.1:87 and 4.2:88)	Modified profile Development of 4th batch of games (4th AR cycle) Planning/Action/Reflect/Evaluate/ Modify (McNiff, 2013)
January – June 2005 Semester 2	Stage I of Application Process and Prototype of the process	Completed Profiles Developed games (5th batch of games) from the 5th AR cycle Planning/Action/Reflect, Evaluate, Modify (McNiff, 2013)
September 2005– January 2006 Semester 1	Stage I of the Application Process and Prototype of the process	Completed Profiles received Development of 6th batch of games from the 6th AR cycle Planning/Action/Reflect/Modify (McNiff, 2013)
January – June 2006 Semester 2	Stage I of Initial Application and Prototype of the process	Completed Profiles received Development of 7th batch of games from the 7th AR cycle Planning/Action/Reflect/Modify (McNiff, 2013)
September 2006- June 2010 Semester 1	Stage I of the Prototype procedure	Further development of 8th-10th batches of games from the 8th-11th cycles Action (McNiff, 2013)

Plan and development of Storyboard

Each cohort of students produced storyboards using information gleaned from their in-depth analysis on a particular end-user's profile. This was used as a baseline for the Design-For-One approach.

The storyboard consisted of a series of sketches showing how the game was progressing (Sharp, et al. 2002; Sharma, 2011). The storyboard provided all the development team with a visualisation of the proposed design whilst the games were being developed.

This aided alleviating any errors at an early stage through careful planning and scheduling before the development of the game.

The pilot (1st AR cycle) of profiles and development of 1st batch of games and dates for Stage I of the initial application began from January 2003 (Table 4.8:111).

Table 4.8 Pilot (1st AR Cycle) of profiles and development of 1st batch of games and dates for Stage I of the initial application (Figs. 4.1:91 and 4.2:92)

Action (1st AR Cycle)	**Dates for Stage I of the initial application**
Profiles for pilot	January 2003
Development of 1st batch	February- June 2003

Evaluation, Testing and Modification (Quality Control) of Storyboard

The storyboards were evaluated by the development team and then sent to the users for evaluation whilst the students were developing the games.

As part of the cyclical approach, the users were asked to evaluate the storyboard and give formative feedback. This gave the users the opportunity to indicate anomalies, problematic issues and improvements to the researcher.

These changes were explained to the students at an early stage in the development to enable modifications and the alleviation of errors before the completion of the games (Reported by Stokes, 2008c). A Design-For-One stage was implemented over seven months from January - June 2003 giving rise to the development of the 1st batch of games.

Evaluation of games by the development team - Pilot of Stage I –1st AR Cycle

The completion of the 1st batch of games was duly evaluated, through the use of an evaluation sheet, by the development team and the other students in the class in June 2003. This was used for quality control purposes. It was to establish the benefits of the games and whether the games had matched the end-users profiles.

This resulted in negative and positive comments given to enable moderation, prior to its completion. It was important to ensure that all the end-users' needs were identified accurately (Reported by Stokes, 2003c, 2014a).

The end-product (the multimedia game) was produced in two formats i.e. Director (dir.) files and executable (exe.) files.

This allowed a further evaluation of the games against the profile and allowed amendments to be made to the .dir files, which were resaved as a new .exe file, for submission to the school. The .exe file of the game allowed the game to run on any Personal Computer (PC) in the school without having to install a very expensive application. The .exe file is a finalised format meaning that no further amendments could be made to the game. These were evaluated and modified by the researcher, who ensured that the numerous games were stored on the appropriate Compact Discs (CDs) for each end-user. These were submitted to the school, together with print outs (screen-shots of the games) for evaluation by the users.

School L underwent a pilot Stage I (1st AR Cycle) and even without any evaluation of the games practitioners agreed to proceed further in this investigation on to Stage I of the process. The reflection of the storage and handling difficulties and limitations the users from School L had with the volume of CDs of the 1st batch of games (Chapter 5:129) led to the iteration of Stage I with the resubmission of blank templates and the completion of profiles. This would enable the users to modify the profiles and complete blank profiles for new end-users (Reported by Stokes, 2003e, 2008a).

*Specific design points in the development of the ga*mes

Text in the game. Using an iterative process this investigation alleviated as much negativity in the games as possible. The games, which were being developed in the early stages of the process, used the term 'wrong' as feedback.

For the cyclical development of games this negative statement was avoided, and consequently more positive encouraging feedback such as 'Try again' were given. This was explained at two conferences (Stokes, 2003c; 2008, 2008c) and in two book publications (Stokes, 2014a, 2014b).

The Design-For-One approach took into consideration the typeface, size, formatting features, colour, how much the end user can read and comprehend words and letters plus their listening skills and diversity of needs, preferences and capabilities indicated on the profiles. This information together with the end user's first name was incorporated into the games appropriately. Their name was used to personalise their games, for cueing and as a motivator and stimulator.

Any additional recommendations by the users relating to any of the multimedia elements, e.g. the end-users' not liking music or barking dogs was indicated by the users on the profiles and then needed to be taken into consideration when amending each end-users' own individual tailored multimedia games. This was highlighted by the researcher the proceedings for the LA Technology and Persons with Disabilities 2003 conference (Stokes, 2003b) and in two book publications (Stokes, 2014a, 2014b).

Sound in the game. The Design-for-One approach took into consideration each end-user's diversity of needs, preferences, capabilities as stated on the profiles in relation to sound. These were appropriately included (or not included) within the game together with the appropriate text giving the end-users, instructions, feedback, etc. (Reported by Stokes, 2003c; 2008a). As some of the end-users enjoyed pop music copyright clearance was acquired by the researcher from the band Coldplay and incorporated e.g. as background music in the games).

The lecturer taught the students how to record and edit Audio and Musical Instrument Digital Interface (MIDI) files for implementing into game using Audio editing software Cool Edit (.wav files) for narration and sound effects with Cubasis Virtual Studio (VST) .mid (MIDI) files also incorporated as background music.

They were instructed by the lecturer (researcher) how to incorporate their own voices and/or record themselves playing musical instruments according to the profile requirements, such as, speaking the end users first name to cue them or as a positive feedback e.g. 'Hello Katie', or 'Well Done Katie'.

Graphics and Animation in the game. As noted in the literature review (Chapter 2:8) end-users with ASD may prefer visual images, which can help with organising and recognition and language. The Design-for-One approach took into consideration each end-user's diversity of needs, preferences, capabilities as stated on the profiles in relation to graphics and animation.

The researcher taught the students to use photographs of actual items and incorporate them into the multimedia games to help ease confusion. This would be dependent on each end-user's comprehension and association with reality as well as being of assistance for increasing their transferable skills in their immediate everyday environment.

As some of the end-users have difficulties with the theory of mind (Moran, et al. 2011) and enjoy egocentric play it was particularly important to design and develop therapeutic and educational games incorporating each end users special interest, if known from the profiles.

The end-user's liking and familiarity of images, such as Disney images, were considered as being special interests for some learners and were, therefore, incorporated into the games. This was to stimulate, motivate and offer them therapeutic and educational opportunities through a safe, fun, consistent onscreen environment.

Students could also use their own graphics (drawn images, photographs and animation) using photo editing software (PhotoShop) and an authoring tool (Macromedia Director version 8.5). This was reported by the researcher in the 2003 LA conference proceedings (Stokes, 2003b).

On reflection, the use of AR for this investigation, through the continuous collaborative partnership and good mutual rapport with practitioners led to a dissemination of good practice and shared gratification by all parties. It was the intention of this investigation that the continuous collaborative interaction with users could result in stimulating and motivating all parties.

This was to gain reflective factual knowledge and increasing the possibility of schools changing their ethos for the adoption of a more whole school approach (McNamara, 2005; Wing, et al. 2012). The CMT/EI process (Figs. 4.1:91 and 4.2:92) enabled a continuous on going, rigorous reflection, modification and amendment of problematical issues. This would give an analysis of the evaluated findings as guidance for drawing conclusions due to the continued maintenance of the games.

Further areas to be taken into consideration

The intention of this investigation was for each game developed to take into consideration the end-users' age and attention span.

The games were kept short and consistent, rewarding the end-user with suitable feedback using the appropriate multimedia elements according to the end-users' modality. This would also relate to their likes and interests.

The games would be developed on the principle that the end-user can interact with the game and can repeat each game several times. This would result in them getting positive and appropriate rewards each time, before proceeding to the next level (easy/medium/hard) or concept (literacy/numeracy/self-help skills/social skills). This could help to reinforce concepts undertaken in the classroom and, giving their good work deserved rewards.

The positive feedback and encouragement would also reduce their frustration. It was important to obtain an evaluation of the more advance games from the users. It would be the user's decision as to the therapeutic/educational suitability of these advanced games for implementation in the classroom.

Evaluation by Users

On receipt of the games, the users involved could carry out assessment, monitor their use and make a judgment concerning the therapeutic and educational benefit. The reason for a cyclical testing process was that it was easier to isolate and fix errors.

Users could reflect on the games, using their expertise and judgment hence they were then able to choose the games they considered to be of most therapeutic and/or educationally beneficial for the end-user. User's formative feedback on the games developed were passed onto the next cohort of students

4.10 2nd AR Cycle - Initial Application

2nd batch of games

This investigation underwent an iterative process with Stage I, as a design and development stage from September 2003 – January 2004 (2nd batch of games; Table 4.9:116) by a large development team.

Table 4.9 Stage I of the initial application 2nd batch from 2nd AR cycle (Figs. 4.1:91 and 4.2:92)

Action	Date carried out
Modified Profile	Not carried out for September 2003
Development of 2nd batch of games (from 2nd AR cycle)	September 2003- January 2004

The data shown in Table 4.10:117 was extracted from the profiles completed by each end-user's users.

Table 4.10 Language used by a group learners in the study

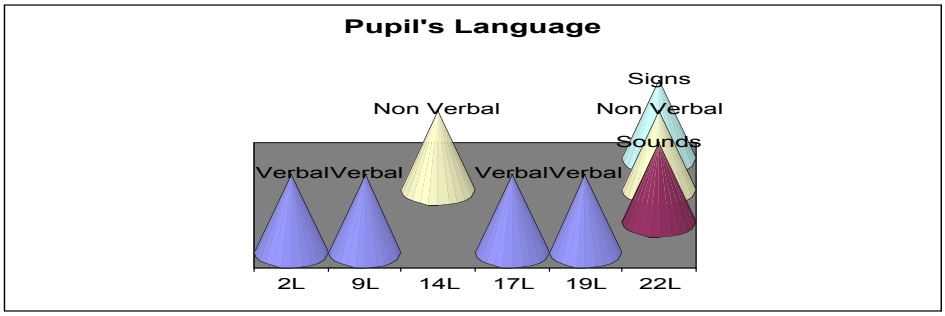
End-users	Age	Language used:
2L	11	Verbal
9L	13	Verbal
14L	13	Non-verbal
17L	16	Verbal
19L	15	Verbal
22L	17	Sounds/Nonverbal/Makaton Sign Language

The anonymity of the school was kept with the use of a reference letter and anonymity of the end user with the use of a number e.g. 2L (end-user) from School L.

Chart 4.1:117 taken from the quantitative analysis of the profiles, that most end-users from School L used a form of verbal language.

Two of the end-user's chosen were non-verbal (one completely non-verbal end-user and the other able to use some sounds and the Makaton sign language to communicate).

Chart 4.1 The form of verbal, nonverbal and sign language used by the end-users.



The speech, language and communication details were taken into consideration when developing games for these end-users. This procedure had an iterative approach with each new cohort of students receiving updated and modified profiles plus feedback from the users involved for amendments, modification and improvements to be made. This procedure was discussed by the researcher in numerous publications (Stokes, 2003e; 2008; 2008a; 2008c).

The students learnt from the mistakes made by their previous peers to enable them to produce more appropriate games for the end-users they were working on. The students took into consideration the updated profiles of the users' changing needs (e.g. able to do single figure addition). They also took into consideration the evaluated feedback from the users, which highlighted the strengths and weaknesses of the games made by the previous cohort for the appropriate modifications.

This was previously discussed by the researcher in her 2008 international journal article (Stokes, 2008a). The process used an iterative autistic-centred Design-For-One cyclical approach enabling cohorts of students to gain academic knowledge and practical skills for the production of products (computer games). This enabled them to gain an understanding for practitioners and learners with disabilities and difficulties in society as part of their academic studies. The developed games were initially evaluated by the other development teams (the class of students and tutors). This was with the intention of identifying errors and give formative feedback on an evaluation sheet, resulting in the games being adjusted accordingly prior to submission for grading. For the assignment, students submitted research reports for grading together with the game. These were evaluated and graded by the tutors and the researcher. Each game was then appropriately modified by the researcher, prior to submitting them to the school. The users received several games per end-users on a CD based on each end-user's individual profiles. This reduced the storage difficulties encountered in the pilot of Stage I (1st AR cycle of the process) and enabled users to evaluate and choose the most therapeutic/educational game for each end-user.

4.11 3rd[d] AR Cycle - Pilot Prototype

Stage I of the process was carried out on an iterative basis (Table. 4.11:119; Figs. 4.1:91 and 4.2:92). However, while the games were continuing to be developed for School L, in its initial application concept, this investigation prototyped the repetitive use of this process with other schools (Schools C, W and R).

Table 4.11 Pilot of Stage II of the Initial Application

Dates	Stages	Process
January/May 2004	Pilot of Stage II the Initial Application	Initial Evaluation (2nd batch from the 2nd AR cycle) Print outs Telephone interview Pilot Diaries Non-participant observation Monitoring/Reflection/ Action (McNiff, 2013)
September /October 2004	Stage II of the Initial Application + pilot of Stage II of the Prototype procedure	Initial Evaluation Questionnaires Pilot Diaries Suggestion and Recommendation Semi-structured Interviews Modified profile Monitoring/Reflection/ Action (McNiff, 2013)
January/February 2005	Stage II of the Initial Application + Prototype of the process	Evaluation of storyboard and games Monitoring/Reflection/ Action (McNiff, 2013)

Schools C, W and R

The practitioners from Schools (C, W and R) were approached by telephone, email and by face-to-face discussion with the principals and users. The project was fully explained and it was agreed that users would choose the end-users that they would consider as benefiting from having specifically individualised games developed. The users would be initially evaluating the therapeutic/educational benefit/value of the games for the chosen end-users, prior to implementation in the classroom.

Stage I of the process was piloted with these schools to assess the continuous use of the process. The aims for piloting Stage I of the prototype procedure was to establish, firstly if other schools were interested in having multimedia games developed for practitioners (users) and their learners with ASD (end-users) and were happy in collaborating with the process and in agreement to complete the profiles in full.

Pilot of Stage I of the prototype began with a template of a permission letter (Appendix 3:269) and blank template of a profile being sent to the school to distribute to the parents/carers of their chosen end-users.

The Stage II Design and development underwent an iterative process (Figs. 4.1:91 and 4.2:92). The researcher explained this process in many of her publications in 2003 (Stokes, 2003c, 2008a, 2008b, 2008c; Stokes and Whitney, 2008). The users in each school chose a number of end-users for this investigation. Their completed profiles were randomly and anonymously distributed to the next cohort of the development team.

The information stated on the profiles were used to carry out in-depth research. This led to the development of individualistic games for the end-users using a Design-For-One approach. Several games (on individual disks) were duly submitted to three schools in June 2004 for the users to evaluate. The researcher had developed and submitted an initial evaluation sheet, which accompanied the games**.**

The teachers (users) were informed that they needed to choose the appropriate therapeutic/educational games.

The researcher made them aware that the standard of the games they would be receiving would due to the mixed abilities of the developers (students). The researcher reassured the staff that any amendments and modifications they suggested would be taken into consideration by the next cohort of the development team.

Their evaluation of the games would provide the development team with what needs to be amended and modified. It would give the staff an opportunity to identify what type of games they wanted to be developed for the therapeutic and/or educational use for their end-user. This led on to piloting the Stage II (Table 4.12:121) – the evaluation, testing and maintenance stage of the pilot prototype of the process (Figs. 4.1:91 and 4.2:92).

4.12 Stage II - Pilot of Initial Application and Prototype Evaluation, Testing and Maintenance

2nd batch of games from the 2nd AR cycle –School L

Practitioners from School L agreed to collaborate with this investigation, which led to Stage II, the evaluation, implementation and testing process (Table 4.12:121). Each user evaluated all the multimedia games and chose the most appropriate therapeutic/educational game for each end-user (Table 5.11:146). This was considered to be their initial evaluation of the games before the actual implementation.

Table 4.12 Timescale of the evaluation and testing of Stage II for School L based on the 2nd and 3rd AR cycles (Figs. 4.1:91 and 4.2:92)**.**

Quantitative and qualitative research methods	**Date carried out**
Initial Evaluation	February–May 2004
Print outs	May 2004
Pilot weekly diaries (4 weeks)	June 2004
Telephone interview made directly into the sound editing package (Cool Edit) on the laptop computer, saved on a disk, transcribed and returned to the interviewee for verification	June 2004
Non participant observations	September 2004
Questionnaires	October 2004
Further testing with of pilot diaries (6 weeks)	November-December 2004
Semi-structured interviews with users	December 2004

Initial evaluation

A blank template of an initial evaluation sheet for each game was given to the school for the users to complete and return. The feedback from the initial evaluation of the games developed gave the users the opportunity to highlight anomalies and suggest improvements before the development of further multimedia games. The comments on the initial evaluation sheets together with the modified profiles were taken into consideration for perfecting the development of further games for each specific end-user.

Print Outs

After the completion of the games, print outs of the games were produced. The researcher enquired with the practitioners from school L whether these could be manually used before the games were implemented in the classroom.

Diaries

The games were tested in the classroom with users completing four and six-week diary entries.

Non-participant observations

To gather further useful data to establish the therapeutic and educational use of the games developed, a non-participant observation technique was carried out. The researcher was able to observe the end-users playing the games in the classroom in the presence of the users.

Interviews

A telephone interview with one of the teachers from School L was carried out, recorded, transcribed, verified and analysed for this investigation. Several semi-structured interviews were also carried out with a number of the teaching staff.

Questionnaires

A questionnaire was submitted for the users in School L to complete.

The investigation carried out a content analysis (Chapter 5:129) on the quantitative and qualitative findings from the initial evaluation, print outs, diaries, non-participant observations, interviews, questionnaires to establish the therapeutic and educational usefulness, benefit/value of individualised therapeutic/educational computer games. This would thereby, indicate the reliability and validity of this investigation (Elo and Kyngäs, 2008). An explanation of this process was broached at conferences by the researcher in 2003 (Stokes, 2003c, 2008a).

2nd batch of games from the 2nd AR cycle – Schools C, W and R

In September 2003, the piloting of Stage II of the prototype enabled the practitioners from Schools C, W and R to carry out an initial evaluation on the 2nd batch of games developed using quantitative initial evaluation sheets. This was to ascertain how they regarded the chosen games would be of therapeutic/educational use for each particular end-user from a content analysis.

School C

The practitioners from School C withdrew from the process (Chapter 5:129) after the completion of Stage I. This indicated to the researcher that the completion and continuous participation of Stage I and/or continuing to Stage II of the process could be considered as an initial predictor that the users were regarding the project as being of benefit or value.

School W

This investigation carried out non-participation observation techniques to obtain quantifiable data from questionnaires submitted to the practitioners of the school.

Seven teachers, one Speech and Language Therapist (SALT) and a professional (who had not indicated on the questionnaire whether they were a teachers or therapist) completed the questionnaire. These were hence referred to as being the users in this school. A content analysis was used to establish the results of the findings.

School R

Stage II of the process was carried out with the practitioners at this school through an initial evaluation of the 2nd batch of games developed.

The practitioners from both schools (W and R) updated and submitted the profiles in July 2004 and Stage I was again repeated.

4.13 Stages I and II of the Initial Application and Prototype

3rd batch of games from the 3rd AR cycle

From January-June 2004, a 3rd batch of games was developed (Table 4.13:124) using Stage I of the process for the end-users from Schools L, R and W from the 3rd AR cycle.

Table 4.13. The 3rd batch of games sent to the schools

Year	Batch of games developed	Batch of games to schools
2004	3rd batch/3rd AR cycle January-June 2005 Initial Application and Pilot Prototype (Semester 1 Small cohort of students)	Stage I 3rd batch of games to schools 'W' 'R' and 'L'.
September	Initial Evaluation from Schools	Schools 'L', 'C', 'W' and 'R'.

Original or modified profiles and the evaluations made by the users on the previous cohort of students' work were used to develop games. This demonstrates an iterative process, which has been raised by the researcher at many conferences (Stokes, 2003c, 2008a, 2008c).

4.14 Monitoring and Reflection

Iterative use of the process

The games were evaluated (for quality control) by the development team. This led to minor amendments to the games before submission for grading by the tutors. The researcher also evaluated and modified all the games (for quality control) before submission to the schools.

Further evaluation of storyboards, print outs and games, prior to the implementation in the classrooms (Figs. 4.1:91 and 4.2:92) were carried out by the users using their expertise. This led to modification of profiles and submission of further new profiles.

4.15. 4th -14th AR Cycles – Prototype

Further batches 4th-14th batches of games- Schools L, R, W, F, CC, H/C, N and S

The whole process was carried out five times from June 2004 - June 2006 using five educational establishments, Schools L, R and W with the inclusion of further new schools, School F, School CC, School N plus a Home/School (H/C) environment.

Once again in-direct randomised end-users were chosen by the users from each school. Again, these developed into the template profiles being modified and extended for the users to complete (Appendix 5:271).

Profiles of School F and Stage I

The template profile was submitted to School F for completion by practitioners. Once again to keep confidentiality and anonymity the school was only referred to as a letter. The practitioners from Schools L, F and CC, H/S and N carried out Stage I on batches 4 - 10 of the developed games as part of the cyclical maintenance of the process. University students were given the end-user's profiles from three of the schools (Schools W, R and School F).

The evaluations and comments made by the users from Schools W and R of the previous cohort of students' work were given to the development team for taking into consideration when developing the 4th batch of individualised games from the 4th AR cycle with a content analysis used on the findings. The next cohort of students considered the users' criticisms and evaluation relating to the specific games developed by the previous cohort of students. The students benefited from autonomous learning, as each student was able to reflect on the faults made by others, whilst formulating their own ideas for their own games. During the development of the games, copies of the storyboards were sent to School F as a pilot to obtain an initial evaluated feedback from the practitioners whilst the games were being developed in the first 4 weeks resulting in a content analysis of the findings.

An iterative process

Stage I of the process was implemented over two semesters with a small cohort of students in Semester 1 (approximately 30 students and 2 academic multimedia tutors) from September – January and in Semester 2 approximately 200 students, from February – June. Thus, demonstrating the process as an iterative process (Table 4.14:126).

Table 4.14. Batches, AR cycles and Dates for Stage I (Design and Development).

Batches of games/AR cycles * SEM 1 - **SEM	Design and Development
1st batch/1st AR cycle**	February- June 2003
2nd batch/2nd AR cycle*	September 2003- January 2004
3rd batch/3rd AR cycle**	January 2004 – June 2004
4th batch/4th AR cycle*	September 2004 – January 2005
5th batch/5th AR cycle**	January 2005 – June 2005
6th batch/6th AR cycle*	September 2005 – January 2006
7th batch/7th AR cycle**	January – June 2006
8th batch/8th AR cycle*	September 2006 – June 2007
9th batch/9th AR cycle*	September 2007 – June 2008
10th batch/10th AR cycle*	September 2008 – June 2009
11th batch/11th AR cycle*	September 2009 – June 2010
12th batch/12th AR cycle*	September 2010 – June 2011
13th batch/13th AR cycle*	September 2011 – June 2012
14th batch/14th AR cycle*	September 2012 - June 2013

Further schools and profiles – Home/School environment, School CC, School N and School S and an extensive profile

Practitioners from a further home/school (H/S) and schools, (School CC and School N) were used and given an extensive blank template to complete. It had become apparent that a more extensive template needed to be completed for the end-users (Appendix 5:271).

Lengthy extended profile

To rectify the problematical issues regarding the limited data completed by the users as previously stated, the profiles were modified to form an extended in depth profile. An explanation was given to the users of the importance of the completing a lengthy profile to enable the development of personalised, individualised games (Appendix 5:271). The aim was to extend the bespoke nature of the games for practitioners and their learners. The objectives were that using a more extensively informative profile of the end-users would highlight the essential therapeutic, educational and autistic needs of each end-user as considered by the users supporting with them.

It was also felt important to include each end-user's first name throughout the games to be used as a cue and for personalising the games.

School CC, H/S N and S

These educational establishments completed these extensive profiles and moved on to Stage I of the CMT process being used (Figs. 4.1:91 and 4.2:92)**.** The practitioners from School N used Stage I of this investigation repeatedly over several years and was still doing so in 2011.

The user from school N left to become the Deputy Head of another school (School S) in Hertfordshire and in 2011, he requested that his new school be included in this investigation. Stage I of the process was implemented for 33 new end-users of primary school with end-users with MLD/disabilities until 2013.

The Deputy Head of Autism and ICT Co-Coordinator of this school regularly came to give talks to all the university students, about each of the end-users and evaluated their work in the classroom, whilst students were still developing the games. He explained how the games were being used in his school and explained how the games were being therapeutically and educationally effective for his learners. This resulted in his written testimonials.

The next chapter will be demonstrating using content analysis the results from the quantitative and qualitative methods used in this investigation.

4.16 Conclusion

To summarise, this chapter has detailed the AR approach adopted for this investigation. It explained sampling methods with the main study using a selection of quantitative and qualitative methods.

The chapter has explored the initial application concept (using a sample population of 136 end-users from one school (School L). The process was then implemented as a prototype with further seven communities, School C, W, R, F, CC, H/S, N and S giving a total of 646 end-users and 49 users.

Comparisons of the different design approaches; guidelines, principals, frameworks and HCI techniques used were discussed. The adoption of a Design-for-One Approach has been explained.

An explanation of the module, the assignment and ethical issues validating this assignment and the benefits of using a real-life situation in academia were given. The anonymous participant's profiles were randomly issued to students for the development of individualised games based on these end-users completed profiles. Two iterative stages of the CMT/EI process, Stage I – Design and Development (Design-For-One approach) and Stage II – Evaluation, Testing and Maintenance were explained (Figs. 4.1:91 and 4.2:92).

Chapter 5
Results

5.1 Introduction and structure of the chapter

This chapter discusses:

- the 1st AR cycle (the 1st batch of games) for 27 end-users from School L (the pilot of the initial application procedure-February-June,2003).
- the 2nd AR cycle (the 2nd batch of games) for a focus group of six end-users from School L (the initial application procedure-September,2003-January2004).
- an explanation of the piloted prototype procedure - 45 end-users from representative schools C, R and W alongside School L is explained.
- how the games were developed (based on the construction and use of the profiles),
- the practitioners (users) evaluation and how they chose games as being of therapeutic (enhancement of language and communication skills) and/or educational (aiding literacy and numeracy skills) (Stage I of the process).
- an explanation of Stage II of the process and the Initial Application and Prototype procedures are given. It shows how the games are implemented in classrooms, users' completion of initial evaluation sheets, piloted and re-piloted weekly diaries, telephone and semi-structured interviews and questionnaires. How the researcher carried out non-participant observations, (based on 2nd and 3rd AR cycles - 2nd and 3rd batches of games (September 2003-June 2004).
- how a content analysis method was used from drawing upon the qualitative and quantitative results.
- the 4th-10th AR cycles development of 4th-13th batches of games - September 2004-June 2013). (educational establishments L, R, W, F, CC, H/S, N and S).
- how quality control difficulties were resolved through iteration and evaluation.

- It makes comparisons between the off-the-shelf games and the games developed through the process used in this research.

The chapter ends discussing students' motivation and the rise in their standard of work suggesting how future software game-developers and researchers can replicate the CMT/EI process.

5.2 Results for Stage I of the initial application procedure

Construction of profiles

Stage I of the initial procedure was piloted and began with the researcher developing a template profile. Categories in the template profile consisted of medical, therapeutic (language and communication skills), educational (literacy and numeracy skills), computer (capabilities) needs, comprehension (understanding) levels, likes (interests), dislikes and additional information. Practitioners completed the profiles on each of their chosen learners. The completed profiles were given a unique identifier (i.e. 1L – 27L) for the 27 learners (end-users) from School L. This was used as a baseline, in a module and assignment, originated by the researcher, by a software development team (cohorts of students and tutors) (Reported by Stokes, 2008a). Over 150 university students developed the 1st batch of computer games in 2003 from limited details on the profiles. Some end-users having four games or more developed for them. Each game being stored on separate CDs and sent to the school.

What has been learnt from the 1st AR cycle

From the task analysis (from verbal and written feedback), the researcher learnt that the user evaluating the volume of games found the physical handling and storage difficulties a time consuming and mundane task for them. Despite these difficulties, they must have envisaged the benefits of the games as the practitioners (users) at School L wanted to continue participating in this investigation. They suggested that the next batch of games should be developed for six end-users (2L, 9L, 14L, 19L and 22L (with 17L included later)). The researcher became aware of their time constraints as unfortunately, the users were unable to modify the profiles.

What has been learnt from the 1st AR cycle in relation to categories and completion of profiles.

The researcher took into consideration the practitioners had a limited time constraints with the second AR cycle by compiling the template profile purposefully with restricted categories. Unfortunately, this resulted in the practitioners giving limited information on the profiles e.g. end-user 2L's profile (Table 5.1:131) did not qualify the severity of the autism (e.g. mild to high functioning) or mention behavioural, social interaction and social imagination difficulties.

Table 5.1 End-user 2L's completed profile.

End-user 2L's profile completed by a user
Medical (problems) **needs:** 11-year-old male with …autism… but …no medical conditions…
Therapeutic (enhance language and communication) **needs:** Verbally
Comprehension level (Fig. 5.2:134 subcategories) '…Variable…'
Educational (literacy, numeracy skills, etc.) **needs** (Fig. 5.2:134 main categories and Fig. 5.3:134 main categories): - Reading level; …Pre-reading… Educational area to develop: …Language, Number skills 1-5…
Computer (capability) **needs:** Software enjoyed: …Stress Reliever, Paint school (game with staff) …
Likes (Interests)**:** - … obsessional with wires, …Ability to learn, musical ability, creative ability…drawing, hoovers and other electrical appliances, painting and colours, spiders and bugs…
Dislikes: Not stated
Any additional information: not stated

End-user 2L's numeracy abilities could have been clarified, e.g. his ability with addition, subtraction etc. together with his computing capability and modality and multimedia element preferences (Chapter 4:88). The user could have confirmed any dislikes. The additional information on the profiles could have referred to the end-users first name so that his games would be personalised. The user should have also described any strategies that were effectively used in the classroom, which could be transferred into computer games to help reinforce the end-user's understanding of particular concepts.

How the handling and storage difficulties occurred from the 1st AR cycle was rectified with the 2nd AR cycle.

Researcher needed to reflect and address the handling and storage difficulties experienced in the pilot of Stage I of the process. This was rectified by all the games for each end-user being incorporated onto 1/2 CDs.

This resulted in being more manageable for the users and led to a positive, iterative, collaborative approach for Stage II of the process (Reported by Stokes, 2008a).

5.3 Stage II of the initial application procedure

Stage II adapted and adopted Elo and Kyngäs's, (2008) content analysis organisational, impartial, abstraction, categorisation method to analyse the findings.

5.4 Contents Analysis Methods

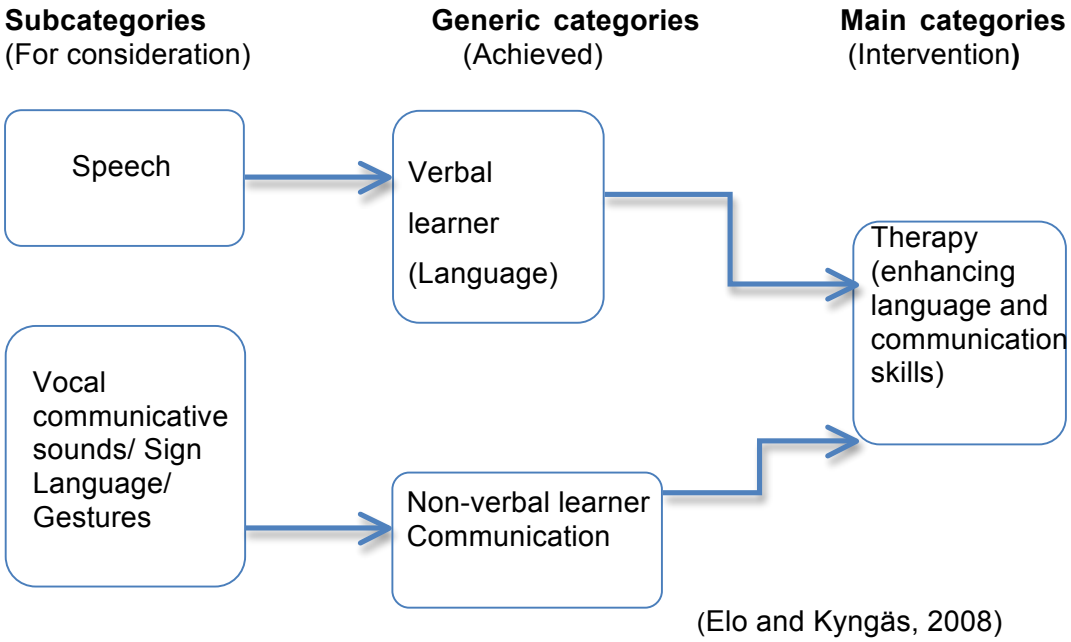
The researcher used her perspective, the users' former knowledge, expertise and understanding of each end-user's diversity of therapeutic/educational needs, the theory/literature research findings (directional approach analysis) and the use of Likert scale to analysis quantitative data, instead of using a single method of coding data. This guided the researcher to use a systematic rule-guided content analysis research technique of using categories (summative content analysis) (Hsieh and Shannon, 2005) to analyse, interpret and describe the meaning of the textual data from qualitative informational contents/keywords (Forman and Damschroder, 2007). This was achieved through an extraction and deduction of the quantitative and qualitative data from the various participants (the users, the students and tutors and the end-users) from:

* the user's completion of profiles
* verbal and written evaluation of storyboards and implementation of chosen games (prior to implementation)
* diaries entries (whilst the games were being played),

* telephone and semi-structures interviews (carried out by the researcher with the users)
* non-participant observations (carried out by the researcher, in the presence of the user and end-user playing with the games)
* qualitative findings from completed questionnaires on the use of the games in the classroom.

The researcher identified gaps and concerns (Table 2.11:62) from literature reviews and this and the raw data from the triangulation methodological analysis helped the researcher assign relevant material to narrowed down groups in the sub (baseline) categorises and generic (standard) categories Figs. 5.1:133 and 5.2:134) (Schreier, 2014).

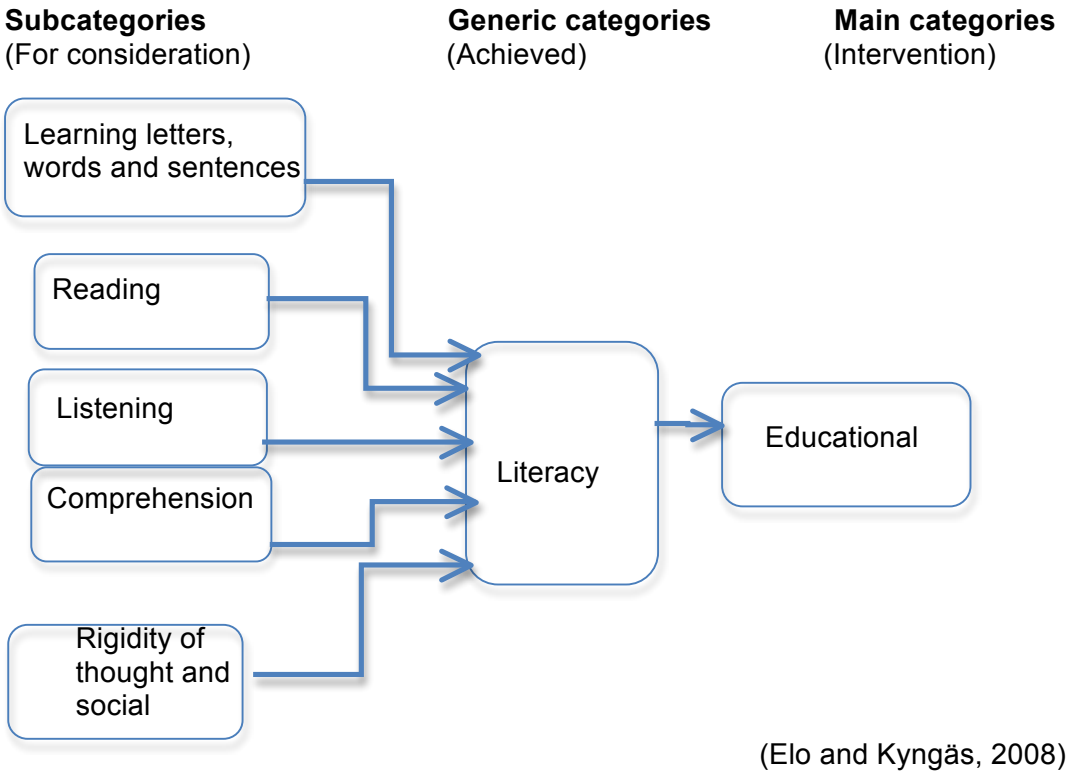
Fig. 5.1 Abstraction categorisation – Therapy (enhancing language and communication skills)



(Elo and Kyngäs, 2008)

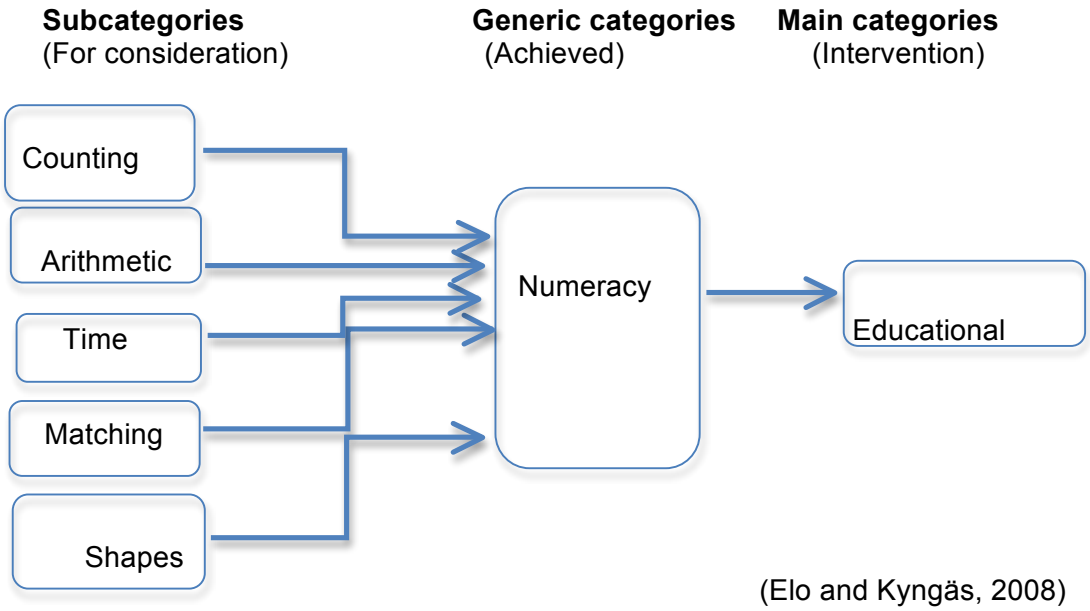
This resulted in enabling the researcher to interpret the underlying context (main (major) categories) to help demonstrate the trustworthiness of the process. The researcher was able to indicate numerous categories on a template profiles.

Fig. 5.2 Abstraction categorisation - Educational (Literacy)



(Elo and Kyngäs, 2008)

Fig. 5.3 Abstraction categorisation - Educational (Numeracy)



(Elo and Kyngäs, 2008)

From the AR cycles the raw data in relation to each end-user's diversity needs, on the completed profiles e.g. as to whether learners used speech or vocal non-communicative sounds, sign language, symbols, gestures or whether they were readers/non-readers and their numeracy levels were placed in the narrowed down sub (baseline) categories (Fig. 5.1:133). This, thereby, indicated the end-user was verbal (Language/Communication) and literacy/numeracy levels reached. This was thereby able to place the data into (Fig. 5.1:133) the generic (standard) categories. The researcher was able to help students identify this and accordingly take this into consideration with the development of the games.

Storyboards and games were evaluated through peer-review (students), tutors and the lecture/researcher to ascertain whether this matched aspects of each end-users' profile.

Furthermore, from the analysis of the (written and verbal) qualitative methods, from the 14 cyclical AR Design-for-one approach, the researcher further narrowed down the generic (standard) categories. This was from her own findings (from non-participant observations) e.g. if the end-users were verbalising or using sign language or reading/counting whilst playing the games. This was further achieved through the extraction of data from a logical questioning process (deductive approach) to answer the research questions (Table 2.13:63) with the objectives (Table 2.12:63) and aims of the investigation being met.

Evidence from the user's monitoring and recording (evaluation, diaries, interviews and questionnaires) indicated that the individualised storyboards/chosen games would be/were of benefit/value for aspects of the end-user's Language/ Communication and/or Literacy/Numeracy needs (Fig. 4.2:92 and 4.3:95 generic categories). This indicated that the storyboard/games would be of benefit/value to aspects of end-users' Therapeutic/Educational needs (Figs. 5.1-5.3:133-134 main categories).

A reflection on the context analysis revealed that it corroborated with the user's initial choice and evaluation that the games developed were demonstrating to be of value/benefit therapeutically (enhancement of language and communications skills)/educationally (literacy/numeracy skills) for their end-users (Fig. 5.1:133 main categories).

This assisted the researcher to acquire, identify and interpret in-depth meaning and understanding, from evidence from the user's expertise, their evaluation of the storyboards/games. It would have indicated as to whether they considered the storyboards/games would be of benefit/value for aspects of these learner's therapeutic and/or educational needs (Fig. 5.1:133 the underlying major context (main categories).

This demonstrates how the raw data from the profiles and the qualitative and quantitative methods were analysed without coding, using both deductive (logical questioning) processes and the adaption and adoption of the challenging task of fine graining (Elo and Kyngäs's inductive analysis). This was an abstraction and narrowing down into groups and categorisation method. It helped the researcher to theorise as to the importance for a collaborative approach with practitioners involved in input, design and evaluation of individualised games. It posited that individualised computer games, developed by students, using a Design-for-One CMT/EI process, in this practice-based AR method has been an effective intervention for aspects of learner's therapeutic/educational needs.

5.5 Quantitative and qualitative methods

Initial Evaluation

The users from School L carried out their initial evaluation of the games (2nd batch of games - January 2004). They chose one game for each end-user, which they considered, would be potentially of some therapeutic/educational benefit. They completed an evaluation sheet (compiled by the researcher), to help them evaluate the therapeutic use (value/benefit) of the games.

This was achieved by asking them questions, such as, to consider whether their chosen game would give the end-user the opportunity for verbal language (Fig. 5.1:133 subcategories). This would help identify whether the games helped aspects of the verbal or non-verbal learner's (end-user's) language and communication (therapeutic) skills (Fig. 5.1:133 generic categories). This lead to ascertaining whether the users considered the games developed would be of some therapeutic (benefit/value) for each end-users (Fig.5.1:133 main categories).

An example of determining the games' educational benefit/value (Fig. 5.2:134 Main categories) was through the user's completion of initial evaluation sheets. These consisted of questions, such as, whether the games developed stimulated speaking, reading and listening through learning activities for (Fig. 5.2:127 subcategories) thereby being of benefit/value to the end-user's literacy needs (Fig 5.2 :134 generic categories).

The researcher learnt from the findings that the user had chosen and evaluated the game '**Learning with Fun'** as being of therapeutic/educational use for the end-user 2L. (Fig. 5.4:142). This game focused on specific aspects on the profile such as the end-user was a pre-reader with number skills 1-5 (Fig. 5.3:134 subcategories), The game for end-user 2L was developed to help the end-user's numeracy skills (Fig. 5.3:134 generic categories) using their interests (in spiders and bugs) with the intention of helping aspects of their educational needs (Fig. 5.3:134 main categories).

What was learnt from the 2nd AR cycle in relation to the practitioner's therapeutic concerns.

The researcher learnt that users had some concerns (e.g. 'may not give the end-user the opportunity for verbal language or instigate more verbal language when used in pairs and/or group work') when they initially evaluated the particular chosen games. These games, however, were developed from limited information stated on the profiles (Tables 5.1:130-5.7:140). It stated that the end-user was 'verbal' against the heading therapeutic needs (Table 5.2:138).

Table 5.2 End-user 9L's completed profile.

End-user 9L's profile completed by a user
Medical (problems) **needs:** …13-year-old, verbal male with ADHD, AS, [with] allergies…
Therapeutic (enhance language and communication) **needs** Verbal– …Language 5/6-year-old...Uses TEACCH.(Fig.5.1:133 subcategories
Comprehension level Fig. 5.2:133 subcategories)**:** Attention and concentration poor due to ADHD. General comprehension good (as reading)
Computer (capability) **needs:** - …good with keyboard. Can recognise letters but spelling poor. Ability with mouse – good… Software enjoyed – …Millie Maths, Baileys Bookhouse, Smudge (first words), Jump Ahead (reading), Pre-school Reader Rabbit. Can recognise letters but spelling poor. Uses individually and with assistance…
Educational (literacy, numeracy skills, etc.) **needs** (Fig. 5.2:134 sub categories): Reading Level - …Level B 5-14 Approx. Primary 2…Attention and concentration poor due to ADHD. General comprehension good at reading… Educational area to develop-…Single figure addition/subtraction in maths. Spelling 3/4 letter words…
Likes (Interests)**:**…Flash cards, music therapy, all art work (A special favourite), stories and working on diary…
Dislikes: Not stated
Additional information: Not stated

Table 5.3 End-user 14L's completed profile.

End-user 14L's profile completed by a user
Medical (problems) **condition:** …13-year-old, nonverbal male with severe learning difficulties' and no medical conditions…
Therapeutic (enhance language and communication) **needs**: Communicates-…with, objects/photos, [but] mainly by taking staff to area of need… A few odd words –infrequent usage. Early successful stages TEACCH and PECS(Fig. 5.1:133 sub categories)
Comprehension Level (Fig. 5.2:134 subcategories): Good level of word structure when willing/interested or simple instructions e.g. …work first, at table, then out on bus…
Computer (capability) **needs:** His computer ability was the minimal use of the touch screen. The game developed needed to be… …Independently for fun. Game enjoyed – …Has used BBC – rockets etc. Very bright, moving and interactive…
Educational (literacy, numeracy skills, etc.) **needs** (Educational area to develop- …Communication… Non-reader (Fig. 5.2:134 sub categories and Fig. 5.3:134 sub categories):
Likes (Interests)**:** Buzz lightyear; Disney DVD/Video
Additional information: …Needs lots of animation, sound, and song around like areas. Interaction through touch screen...

Table 5.4 End-user 17L's completed profile.

End-user 17L's profile completed by user
Medical (problems) **needs:** A …16-year-old, verbal male. General good health
Therapeutic (enhance language and communication) **needs:**: Verbal. Makes needs known through using two, three words together. (Fig. 5.1:133 sub categories)
Comprehension Level (Fig. 5.2:127 subcategories) –'as above'
Educational (literacy, numeracy skills, etc.) **needs**: …Reading…5/6 years… Educational area to develop: Communication and Language. Self-help in community e.g. shopping, awareness of money. (Fig. 5.2:134 sub categories and Fig. 5.3:134 sub categories)
Computer (capability) **needs:** …Can co-operate independently with keyboard and mouse and does not sit in class apart from sensory and snack times'. Likes software: Millie Maths, Simple spelling, Wellington Square Level 1, Lets Go shopping.
Likes (Interests)**:** Loves baking. …Enjoys swimming, horse riding and music
Additional information: …Needs games produced with healthy eating, motivated by food.

It did not elaborate that his therapeutic needs would have benefited if the game was developed for use in pairs and/or group work. If it had the development team would have developed the games bearing this in mind. The researcher had learnt that the users also evaluated these games for encouraging speech, sign language, gestures, symbols or sounds, thereby being of some therapeutic benefit to all the end-users (Fig.5.1:133 main categories).

Table 5.5 End-user 19L's completed profile

End-user 19L's profile completed by user
Medical (problems) **needs:** A 15-year-old male …challenged by autism.
Therapeutic (enhance language and communication) **needs::** …Verbal language – Uses up to 100 words to communicate basic needs. Gestures and symbols used: Can use communication books and symbols and can gesture and lead. Always uses a TEACCH system… (Fig. 5.1:133 sub categories**)**
Comprehension level (Fig. 5.2:127 subcategories)**:** Age 4
Educational (literacy, numeracy skills, etc.) **needs** (: Educational area to develop: …Communication and Language Numbers 1-10. Self-help skills (P.S.E) Reading Level: …Pre-Reading 3/4… Fig. 5.2:134 and Fig. 5.3:134 sub categories)
Computer (capability) **needs:** …can operate independently including use of mouse'. Not very good at finding letters on keyboard. Software enjoyed: Millie Maths, Pre-School Reader Rabbit. Simple Spelling…
Likes (Interests)**:** …Cartoons i.e. Tom and Jerry, Thomas-the-Tank Engine etc. Loves sudden noises or toys that play music. Enjoys cutting and posting favourites particularly Thomas-the-Tank Engine…
Dislikes: Not stated
Additional information: Not stated

Table 5.6 End-user 22L's completed profile.

End-user 22L's profile completed by user
Medical (problems) **needs:** A…17-year-old, male. Moderate autism
Therapeutic (enhance language and communication) **needs** …Non-verbal. Uses Makaton also uses pictures and photographs.. (Fig. 5.1:133 sub categories)
Comprehension Level (Fig. 5.2:134 subcategories)– …Understands spoken word 90% of time. Also, can use tools, machines for specific jobs…(as reading). (Fig. 5.1:133 sub categories)
Educational (literacy, numeracy skills, etc.) **needs:** Educational area to develop- …Single figure addition/subtraction in maths Spelling ¾ letter words. Communication development. Outside working opportunities… Reading …Not measurable…'(Fig. 5.2:134 and Fig. 5.3:134 sub categories)
Computer (capability) **needs:** …Can use mouse well. Adequate ability, can perform 60 piece jigsaws easily. Uses PC games e.g. Tonka games (3-5 years). Simple construction CD. Jigsaw games'. Game to be used by 'More advanced construction CD's. Sound, lotto, visual – matching etc.
Likes (Interests)**:** …PC work especially jigsaw puzzles of machinery, trucks etc. He did enjoy Tonka originally but prefers completing the tasks of jigsaws and printing out finished pictures... Good patience when learning new skills.
Dislikes: Not stated
Additional information: – …More advanced construction CDs. Sound, lotto, visual- matching etc.

Table 5.7 Initial qualitative findings from the evaluation of the games.

End-users	**Initial concerns of the users**
2L	The game **'Learning with Fun'** (Fig. 5.4:142) may not give the end-user the opportunity for verbal language or instigate more verbal language when used in pairs and/or group work.
9L	The game **'Bright Start'** (Fig. 5.5:143) may not help to show the relationships, interaction with others, instigate more verbal language if used in pairs and/or group work or help to present, share, clarify and reflect on ideas, social imagination, and interests.
14L	The user was unsure whether the game **'Tara's Day Out'** (Fig. 5.6:146) would instigate verbal language and give the end-user the opportunity for verbal language when used in pairs and/or group work or help relationships and social interaction.
17L	The user was unsure whether the game **'Buy and Bake'** (Fig. 5.7:147) would help the user express feelings and/or opinions and make language development fun or whether it would instigate more verbal language if used in pairs and/or group work.
22L	The user was unsure whether the game **'Select O Match'** (Fig. 5.8:148) would instigate verbal language if used in pairs and/or group work.

Results identified from the 2nd AR cycle as to users further continuous involvement in this investigation.

At this stage users could have ceased their involvement in the investigation due to their time constraints, heavy workload or if they regarded the games as not being of either therapeutic and/or educational use for their end-users.

Nevertheless, the practitioners from School L continued participating in this investigation with the results from the content analysis findings highlighting the practitioner's many evaluative positive qualitative complimentary comments. The researcher reflected on this and it suggested strong evidence that the users were evaluating the games as being of therapeutic/educational benefits/value.

What was identified from the 2nd AR cycle as to whether the games made language development fun.

The researcher's reflection of the findings resulted in her learning that the majority of the users predicted that the games developed would make language development fun (Table 5.8:141).

Table 5.8 Positive findings from the initial evaluation on the 2nd batch of game

Potential therapeutic use
The majority of the users envisaged that the games would instigate functional or non-functional use of language, in the form of speech, sign language, gestures, symbols or sounds (Fig. 5.1:133 subcategories).
The majority of the users envisaged the games developed provided a language environment, which would stimulate the end-user (Fig. 5.1:133 subcategories).
The majority of the users envisaged that the games developed gave the end-user the opportunity for verbal language (Fig. 5.1:133 subcategories).
All the users envisaged that the style of language in the games were appropriate for verbal language and for the specific autistic end-users (Fig. 5.1:133 subcategories).
All the users envisaged that the games made language-learning fun (Fig. 5.1:133 subcategories)

What was identified from the 2nd AR cycle as to whether the games would be of educationally beneficial/value.

The researcher's reflection of the results indicated strong positive findings, from the users' evaluations of all the chosen games from the 2nd batch, that the games were of educational benefit/value for their end-users (Figs. 5.1- 5.3:133-134 main categories (Tables 5.9:142-5.11:146).

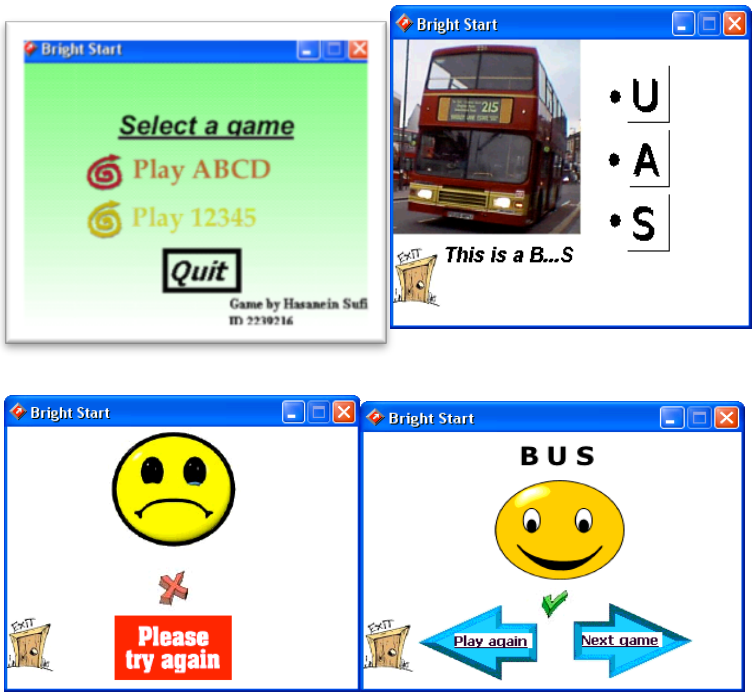
Fig. 5.4 Screen shots from the 'Learning with Fun' game developed for end-user 2L.

1st Row Left - 'Introduction screen'. 1st Row Right - 'Main Menu screen'
2nd Row Left - 'Question 2 Number skills game'. 2nd Row Right - 'Question 4 Language skills'
3rd Row ('Score Information. Feedback 'Congratulations' 'Well Done'

Table 5.9 Positive findings on the 2nd batch of games

Potential educational use
All the users envisaged that the game conveyed useful educational information, instructions and/or direction
Most the users claimed that the game provided learning activities in speaking, listening, reading etc. (Fig. 5.2:134 subcategories)

Fig. 5.5 Screen shots from the game 'Bright Start' developed for end-user 9L



1st Row Left - 'Main Menu screen'.
2nd Row Left - 'Feedback on incorrect answers'.
1st Row Right game'
2nd Row Right – 'Feedback on correct answer'

A blank (template) weekly diary was designed by the researcher for the users. These diaries were copied and completed by the users (School L) over four weekly sessions. The users chose five end-users (3 verbal and 2 non-verbal end-users) to play games from the 2nd batch developed in June 2004.

What has been learnt from the 2nd AR cycle from results of the pilot weekly diaries

The researcher learnt from the analysis (Table 5.12:149) of the weekly diaries that these individual games (which were also chosen and evaluated by their users) were of therapeutic/educational benefit/value for their end-users. The weekly diaries demonstrated that some learners used verbal, communicative sounds and non-verbal communication (sign language) whilst they played the games (Fig. 5.2:133 generic categories). One verbal end-user 19L used verbal language (Fig. 5.1:133 subcategories). Another verbal end-user 2L and two non-verbal end-users 14L and 22L used communicative sounds (Fig. 5.1:133 subcategories) when playing the games over 4 weeks (Table 5.11:146).

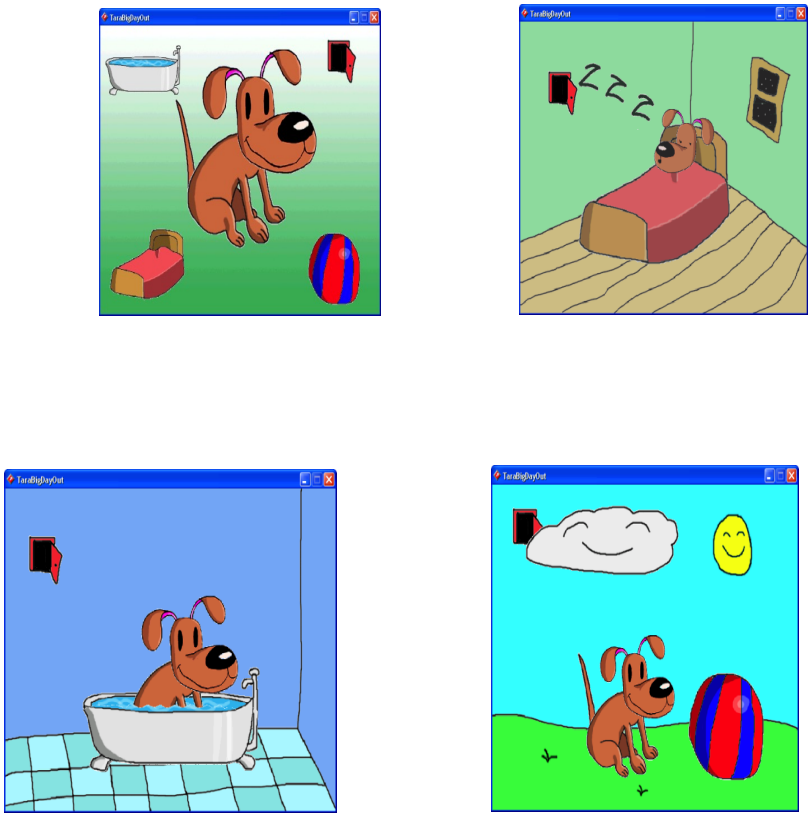
Table 5.10 Positive findings as to the educational use of the chosen games

End-users	**Positive qualitative evaluation by the users on the games developed and based on the profiles** (Tables 5.1:130-5.6:139)
2L	The **'Learning with Fun'** game (Fig. 5.4:142) took into consideration that this end-user needed a game that would help his reading and numeracy skills through his likes in spiders and bugs (Table 5:1:130). The user's evaluation of the game indicated that it would stimulate this learner's speaking, reading and listening skills (Fig. 5.2:134 subcategories) through the useful educational information, instruction and/or direction in the learning activities incorporated in the game. This would help end-user 2L's literacy skills (Fig. 5.2:134 generic categories). The user also felt that it would help the end-user express their feelings, experiences and/or opinions or share, clarify and reflect on ideas, social imagination and interests. This demonstrates that according to the user the game would enhance this end-user's language and communication needs and would be of benefit/value to aid their literacy and numeracy skills (Fig. 5.1:133-5.3:134 generic categories). This thereby suggests strong support that individualised games (such as this game's individually developed for this end-user 2L) would address learner's therapeutic and educational needs (Figs. 5.1:133 and 5.2:134 main categories).
9L	The game **'Bright Start'** (Fig. 5.5:143) was developed to assist this end-user's with spelling, addition and subtraction through his likes in flash cards, music, art, and stories. (Table 5.2:138). The user's evaluation of the game was that it provided learning activities with useful educational information, instruction and/or direction. This strongly supports that individualised educational games would aid their literacy needs (Fig. 5.2:134 generic categories) and thereby are of benefit/value for their educational needs (Fig. 5.2:134 main categories). The user also felt that the game provided the end-user with a stimulating opportunity for verbal (speaking) language and listening. This made language development fun (Figs 5.1:133 and 5.2:134 subcategories). This also strongly supports that individualised therapeutic games would assist in enhancing the end-user's language and communication skills (Fig. 5.1:133 generic categories) and would thereby, help this end-user's therapeutic needs (Fig. 5.1:133 main categories).
14L	The game **'Tara's Day Out'** (Fig. 5.6:146) was developed for this non-verbal learner, as he needed a game to help his communication skills. The game needed to have simple instructions, objects or photos as he had minimal use of the computer. (Table 5.3:138). The user's evaluation of this individualised game was that it provided the end-user with learning activities, which could eventually assist this end-user with communication (Fig. 5.2:134 subcategories). Since the game conveyed useful educational information, instruction and/or direction this would assist this end-user's educational needs (Fig.5.2:134

End-users	**Positive qualitative evaluation by the users on the games developed and based on the profiles** (Tables 5.1:133-5.6:134)
17L	The game **'Buy and Bake'** (Fig. 5.7:147) was developed for this verbal learner to help his communication, language and self-help skills (shopping and awareness of money) with his love and motivation by food. (Table 5.4:139). The user claimed that the game provided the end-user a language environment, which could stimulate and instigates language (Fig. 5.1:133 subcategories) and could help the end-user relationships and interact with others. This could enhance this end-user's language and communication needs (Fig. 5.1:133 generic categories) and assist the end-user's therapeutic needs (Fig.5.1:133 main categories). The user also indicated that the game provided the user with learning activities for reading, listening and speaking (Fig. 5.2:134 subcategories) giving the end-user an opportunity for verbal language (Fig.5.1:133 subcategories). The user also indicated that the game conveyed useful educational information, instruction and/or direction, and could help to present, share, clarify and reflect on ideas, social imagination and interests. This could assist the end-users literacy skills resulting in helping their educational needs.
19L	The game **'Counting the animals'** (Fig.5.9:14) needed to be developed to help his numeracy, literacy or self-help skills taking into consideration that he liked cartoons, sudden noises, music, cutting, posting and Thomas-the-Tank Engine (Table 5.5:139). The user evaluated the game and indicated that the game gives the end-user the opportunity for verbal language (Fig. 5.1:133 subcategories), instigating further language through conveying useful educational information, instruction and/or direction. This demonstrates that the game could help to enhance this end-user's language and communication abilities and help their numeracy skills (Figs.5.1:133 and 5.2:134 generic categories). This could aid their therapeutic and educational needs (Figs. 5.1:133 and 5.2:134 main categories).
22L	The game **'Select O Match'** (Fig. 5.8:148) was developed for this nonverbal learner to help him with addition, subtraction, spelling and/or communication through this enjoyment of jigsaw, machinery, trucks and transport (Table 5.6:140). The user's evaluation of the game indicated that the game provided a language environment, which may give the end-user an opportunity to instigate and stimulate speaking and language, making language development fun (Fig. 5.1:133 subcategories). The game could help the end-user express feelings, experiences and/or opinions whilst helping relationships and interaction with others. This, thereby, suggests strong support that individualised therapeutic games could help nonverbal learners.

On reflection, this demonstrated that the games were potentially of some therapeutic/educational use for the end-users (Figs 5.1:133-5.3:134 main categories).

Fig. 5.6 Screen shots from the game 'Tara's Day Out' developed for end-user 14L



1st Row Left - 'Home screen'.
2nd Row Left 'Story two'.

1st Row right - 'Story one'.
2nd Row Right Feedback at end

Table 5.11 The findings from the users' evaluation of the games

All six users	Majority of the users
The games conveyed useful educational information, instruction and/direction and made language fun.	The games provided a language environment, which stimulates end-users whilst providing learning activities in speaking, listening, reading (Fig. 5.2:134 subcategories) and an opportunity for verbal language (Fig.5.1:133 subcategories) The games may instigate language. It helped relationships and helped end-users' interaction with others. This gives further strong support that most users were agreeable that individualised games could be of therapeutic and educational benefit/value to learners with ASD.

Fig. 5.7 Screen shots from the game 'Buy and Bake' developed for end-user 17L

1st Row Left - 'shop screen to buy item'. 1st Row Right - 'To choose money
2nd Row Left - 'Cooking'. 2nd Row Right - 'Baking'
3rd Row - 'To go back to shop'

The researcher carried out a telephone interview with the Head of Education (The Interviewee - the user) who was overseeing the research at School L in June 2004. This was transcribed and verified.

What was learnt from the 2nd AR cycle from the results from a telephone interview

The researcher learnt from an analysis of the qualitative findings from an interview with the user (from their expertise, knowledge and understanding the end-users therapeutic/educational needs), that these end-users had a desire to communicate (Fig. 5.1:127 generic categories). However, this is dependent on their individual level of autistic needs. All the end-users do have something to say but they do not know how to say it.

Fig. 5.8 Screen shots from the game 'Select O Match' developed for end-user 22L

1st Row Left - 'View picture'.
2nd Row Left - 'Feedback to correct answer'.
1st Row Right - 'Choose Matching picture'
2nd Row Right - 'Offering a prize'.

Furthermore, they are not given the opportunity to say it. It was further learnt that it was the school's responsibility to try and work out what end-users want to say and then 'empower' them 'to say it' by encouraging them to express themselves through choosing the appropriate means giving them 'a more augmented form of communication and accessibility to a wider range of students in *a totally communicative environment'*. This was achieved through the CMT/EI process giving end-users a further individualised means for communication through a totally augmented communicative environment. The researcher had learnt from interviewee that the school had not focused on verbal language development (Fig. 5.1: 133 subcategories). This investigation has resulted in the staff having more discussions around individualism.

Table 5.12 End-users' verbal language whilst playing on the games over 4 weekly sessions.

End-users	End-users' verbal language	Teachers' monitored and recorded negative diary entries	Teachers' monitored and recorded positive diary entries.
2L	*'Giggles + Mmmm Singing (no words)'* (Fig. 5.1: 133 subcategories)	Not stated	Not stated
9L	Not stated	*'Grey - sound poor' graphics small and bright hard on eyes 'too slow between sentences'.*	Not stated
14L	Not stated	*'Words flashing, colours, hands rubbing over screen. Random - flashing colours Quickly distracted; tongue on screen- little focus. Full support required to use hand'.*	*'Exited at sounds (Fig. 5.1:133 categories) but first time back on computer. Briefer interaction; appeared to be looking for more than verbal response'.*
19L	*'Said names of characters and counted aloud. Well done said'.* (Fig. 5.2:134 subcategories)	*'No real interest, gesture for help to change. Found very easy and not that motivating Speech very unclear Named all characters shown'.* (Fig. 5.2:134 subcategories).	*'A nice concept – Repeated Once supported managed to work easily. Very easy to work and move from screen to screen. Very motivated in using the programme'.*
22L	*'Giggled and laughed at ghost and attempted to make sound of owl…Liked telling me colours. Good attempt tried to make sounds of animals*'. (Figs. 5.1:133 and 5.2:134 subcategories)	Not indicated	*'Signed boat. Enjoyed listening to all (Friendly programme) Asked if he like music - asked him to point to other objects on screen, pointed correctly and signed each Using pictures to instigate discussion. Signed about colour of animals Asked to sign all objects used correct Makaton Enjoyed using pictures to instigate discussion and teaching. Really good program*'. (Figs. 5.1:133 and 5.2:134 subcategories).

Fig. 5.9 Screen shots from the game 'Counting the animals' developed for end-user 19L

1st Row Left - 'First game'.

2nd Row Left - 'Feedback to incorrect

1st Row Right - 'To count and choose numbers'

2nd Row Right - 'Feedback to correct answer'.

Table 5.13 Effective methods used in the school environment for verbal language skills (Fig. 5.1:133 subcategories)

Effective methods used in the classroom
PECS
TEACCH
Makaton sign language
Use of minimal language
Focus on keywords
Tonality of voice
Musicality
Signing used for requests, comments and commands

The Interviewee claimed that a 'fantastic job' [had been achieved in view of the] 'limited, inadequate information [which was given in the first instance] on the profiles' (Tables 5.1:130-5.6:139). This was due to lack of information on the profile from the lack of involvement by the present staff from the beginning.

The researcher learnt that the current methods used in the classroom to enhance each end-user's language and communication skills (Table 5.13:150; Fig. 5.1:133 generic categories) were PECS, TEACCH and Makaton sign language (Table 5.13:150; Fig. 5.1: 133 subcategories).

If these approaches had been specified on the profiles as being important, they would have been incorporated into the individualised games together with the inclusion of text, sound and animation for motivating and stimulating language.

The researcher further learnt from the qualitative results of technical anomalies, such as, the slowness and difficulty in playing and keeping the game working. This was corrected through the iterative process.

Nevertheless, it showed the Interviewee's satisfaction 'with the variety and concept [of the games] were great for our particular individuals' (Reported by Stokes, 2008c; 2003c).

What was learnt from the 2nd AR cycle from the results of the non-participant observations

The researcher carried out non-participant observations and monitored the effects of four of the end-users, (two non-verbal end-user 22L and 14L and two verbal end-user 19L and 9L) playing with the chosen games (2nd batch - September 2004) in the classroom, in the presence of the user. End-user 14L, however, became very agitated as the user had great difficulties in loading up the game and had to abandon it. This may have been due to several difficulties, such as, the staff's lack of IT training. These days, however, the staff are much more computer literate. Furthermore, the researcher found it difficult to accurately, manually monitor and record the observations owing to the user's exuberance in showing the researcher the educational capabilities of the end-user's achievements with the game and resulted in limited data being documented.

The researcher, however, learnt from the documented evidence (Table 5.14:152) strong verification that the individualised games developed and played with by four of the end-users were of therapeutic use for three of the end-users.

Table 5.14 Verbal and non-verbal communication recorded during non-participant observations.

End-user	Games	Profile stated	Use of verbal communication whilst playing with game	Use of non-verbal communication whilst playing with game
9L	'Bright Start' (Fig. 5.5:143)	Communicates – 'Language 5/6-year-old' (Fig. 5.1:133 subcategories)	'Used single words which were spoken in context' (Fig. 5.1:133 generic categories)	'Made vocal communicative sounds (giggles + mmms') (Fig. 5.1:133 generic categories)
14L	'Tara's Day Out' (Figs. 5.6:145)	'Non-verbal – No speech. Objects/photos, mainly by taking staff to area of need'. (Fig. 5.1:133 subcategories)	None used	None used
19L	'Counting the animals' (Fig. 5.9:150)	'Verbal. Communicates – Language 5/6-year-old' (Fig. 5.1:127 subcategories)	'Used single words and sentences out of context' (Fig. 5.1:133 generic categories)	'Made vocal communicative sounds (giggles + mmms) (Fig. 5.1:133 generic categories)
22L	Select O Match (Fig. 5.8:148)	'Non-verbal – No speech. Uses a form of Makaton. Also uses pictures and photographs'. (Fig. 5.1:133 sub-categories)	None used	'Used sign language with vocal communicative sounds' (giggles + mmms) (Fig. 5.1: 133 generic categories)

This was through the verbal language (single words and sentences (in and out of context) and non-verbal communicative vocal (sounds).

It can also be seen by sign language (Fig. 5.1:133 generic categories) used by the end-users whilst they played with the games, e.g. non-verbal end-user 22L used sign language with vocal communicative sounds whilst playing the game (Fig. 5.1:133 generic categories). Two verbal end-users 19L and 9L were both used words and communicative sounds whilst playing their games (Fig. 5.1:133 generic categories). This demonstrated that the individualised games met their therapeutic needs by enhancing the end-user's language and communication (Fig. 5.1:133 main categories) and were thereby of therapeutic benefit for the end-users.

What was learnt from the 2nd and 3rd AR cycles from the results from the Questionnaire

The researcher learnt from the results that the analysis of the questionnaires findings that the individualised games enhanced the end-user's language and communication/literacy/numeracy skills (Figs. 5.1:133-5.3:134 generic categories). Questionnaires were completed by the users of four of the end-users (2L, 14L, 17L and 22L) in October 2004. A five point Likert scale was used to measure how the users rated the games giving the respondent choices to consider from an excellent high rating = 1, a neither high/low rating = 3, to a poor/low rating = 5 (Table 5.15:154, Dawes, 2012). This demonstrated that the individualised games were of therapeutic/educational benefits/ value (Figs. 5.1:133-5.3:134 main categories) e.g. the user chose the game **'Learning with Fun'** developed for end-user 2L and implemented the game in the classroom (Table 5.15:154). The user evaluated the game. The researcher learnt from analysis of the findings that the user gave the game a high rating for its therapeutic and educational benefits/value (Figs. 5.1:133 and 5.2:134 main categories) and gave a good rating for the standard of the production of the game.

What was learnt from the 2nd and 3rd AR cycles, from the evaluation of resubmitted weekly-piloted diaries, based on the 3rd batch of games.

Resubmitted six-week piloted diaries (originated by the researcher) were copied and completed by the users (School L) and based on the 3rd batch of games (Table 5.16:156).

Table 5.15 Rating from the questionnaire

End-users	Therapeutic (Fig. 5.1:133 main categories)	Educationally (Figs 5.2 and 5.3:134 main categories)	Production
End-user 2L - **'Learning with Fun'**	Received a high rating for the game instigating non-functional language (communicative vocal sounds) and for encouraging and giving the end-user and others an opportunity for more functional verbal language, when used in pairs and/or for group work. (Fig. 5.1:133 generic categories)	Received a high rating for conveying useful educational information, instruction and/or direction whilst helping to present, share, clarify and reflect ideas, social imagination, interests, as well as being aesthetically pleasurable. It incorporated learning activities, which were of educational use for speaking, listening, reading, thereby, being appropriate for meeting this end-user's educational needs. (Figs. 5.2:134 and 5.3:134 generic categories). This was for the game conveying useful educational information, instruction and/or direction and helping the end-user express his feelings. It provided learning activities in speaking, listening and reading as well as helping the end-user to present, share, clarify and reflect his ideas, social imagination and interests (Figs. 5.2:134; 5.3:134 generic categories)	Being at a good standard (not excellent yet not poor) with simple and natural terminology used for navigation.
End-user 14L **The Learning Game'**	A high therapeutic rating received for being good at helping the end-user express his feelings, and/or opinions, giving the end-user and others a good opportunity to develop their functional verbal language (Fig. 5.1:133 generic categories)	The user gave an average educational rating for the game for meeting the end-user's educational needs. (Figs. 5.2:134 and 5.3:134 generic categories)	A good rating for the production of the game, for the navigation through the game and the simple and natural terminology used.

End-users	Therapeutic (Fig. 5.1:133 main categories)	Educationally (Figs. 5.2:133 and 5.3 :134 main categories)	Production
End-user 17L **The Buy and Bake' game** (Fig. 5.7:147)	A high rating gained for the game providing a fun verbal language environment. This gave the end-user and others an excellent opportunity for instigating functional verbal language (Fig. 5.1:127 generic categories)	A high educational rating was received for meeting the end-user's educational needs. experiences and/or opinions.	The production of the game was again highly commended by the user who claimed that the navigation and terminology used was of a very good standard.
End-user 22L **Select-O-Match** (Fig. 5.8:148)	A high therapeutic rating was received for the game encouraging an excellent use of verbal language. (Fig. 5.1:133 generic categories	A high educational rating was received for the game providing learning activities for speaking, listening and reading. (Fig. 5.2:134 generic categories)	Not stated

The researcher learnt from the analysis of the findings strong support of language and communication emerging from the end-users, the users and the games being played in the classroom (Fig. 5.1:133 main categories). Some users used language (by talking to the end-users) whilst the games were being used, with end-users 17L, 19L and 22L. (Fig. 5.1:133 generic categories). The user also claimed that she had worked with this end-user for two years and that he was inclined to always make the same kind of noises no matter what they did. His language had not developed and she doubted it ever would. The user felt that the game seems to stimulate and motivate this particular end-user.

The end-user 19L's game had produced the sound of dogs barking which distressed him. Interestingly, the user was unaware that the end-user had a fear of dogs and had, therefore, not stated this on the end-user's profile under the categories of dislikes. Nevertheless, barking could also be incorporated into generic shop bought games.

Table 5.16 Qualitative results from 6-weekly diary sessions

End-users and games	Language and Communication from end-user during sessions	Language from users during sessions
End-user 2L **–** **Learning with Fun** (Fig. 5.4:142)	'Communicative vocal sounds such as giggles, mmmm and singing in each session' (Fig. 5.1:127 generic categories)	None stated
End-user 9L – **Splodge, Emotions, Fun Music**	'Instigated appropriate verbal language in each session with the End-user producing verbal language and communicative sounds by laughing and spelling words' (Figs. 5.1:133 and Fig. 5.2:134 generic categories).	None stated
End-user 14L – **The Learning game, Planet** (Fig. 5.10:157)	Produced 'communicative sounds and was looking for more verbal response' in weekly sessions.	None stated
End-user 17L - **Buy and Bake and Let's Cook** (Fig 5.7:146, Fig.5.11:158)	'Used a lot of verbal language in context during the weekly use of the games' (Figs. 5.1:133 and 5.2:134 generic categories)	User used verbal interaction
End-user 19L - **Shape, Dressing Up, Counting and Guessing games**	'The end-user produced verbal language and communicative vocal sounds in weekly sessions' (Fig. 5.1:133 generic categories)	Verbal interaction used from the user
End-user 22L - **Howie, Select O Match, Match** (Fig 5.8:147	'Produced non-communicative sounds and sign language in weekly sessions' (Fig. 5.1:133 generic categories)	The user used verbal interaction and encouragement

Through the iterative development process this was rectified, with the omission of dogs barking in the development of individualised games for this end-user by the next cohort of students.

The researcher learnt from the users that there was a continuous improvement in the games being developed e.g. the sample of screen shots taken from the **'Planets'** game for end-user 14L (Fig. 5.10:157) and **'Lets Cook'** game for end-user 17L (Fig. 5.11:158).

Fig. 5.10 Screen shots from the game 'Planet' developed for end-user 14L

1st Row Above Left - 'Introduction screen'.

1st Row Above Right - 'Select and match'

2nd Row Below Left - 'Feedback on correct. verbalisation'

2nd Row Below Right 'Encouraging answer'.

3rd Row Below Right Encouraging. verbalisation'.

3rd Row Below Left – Completion of game.

Fig. 5.11 Screen shots from the game 'Lets Cook' developed for end-users 17L

1st Row Left - 'Welcome screen'.
2nd Row Left 1st row - 'To get ingredients'.
3rd Row Left 2nd row – 'To the shop'.
4th Row Left 3rd row – 'shopping for 'ingredients'.

1st Row Right - 'Introduction'
2nd Row Right 1st row 'Transportation'
3rd Row Right 2nd row – Choosing what to cook
4th Row Right 3rd row – Incorrect choices'

Fig. 5.11 cont./. Some screen shots of Let's Cook game for end-users 17L

1st Row Above Left - 'Choice of money'.
2nd Row Below Left - 'Feedback on correct choice'.
3rd Row Last scene – ' choice to play again'

1st Row Above Right – 'incorrect choice'.
2nd Row Above Right –'Feedback' picture ' of cooked item'

What has been learnt from the 2nd and 3rd AR cycles from the results from semi-structured interviews

The researcher carried out semi-structured interviews with the users of four out of the six end-users (end-users 2L, 9L, 17L and 19L) based on the 2nd and 3rd batches of games. The researcher established from the analysis of the results, the interviewees' confidence as to the therapeutic and educational benefits of the games for their learners (end-users) (Fig. 5.1:133 main categories).

The researcher learnt that for end-user 2L - the chosen game **Learning With Fun** stimulated and motivated this learner to produce communicative vocal sounds whilst using the game (Fig. 5.1:133 generic categories).

The user of end-user 2L was confident that this specific game would be used, in different ways through play, to help him increase his sounds and verbal language. This would enhance his language and communication and aid his literacy skills (Figs. 5.1 and 5.2:133-134 generic categories). This corroborates with the user's initial evaluation that the game would be (and was demonstrating to be) of therapeutic and educational (Figs. 5.1 and 5.2:133-134 main categories) use for this end-user.

Interestingly, the researcher learnt from two users (Interviewee and Interviewee2) that end-users 9L and 19L were two verbal learners (Fig. 5.1:133 subcategories) in the same class. End-user 19L, however, 'only has keywords but is not motivated to speak'. The researcher further learnt that one of the users had decided to use the same game (**Emotions,** which had been developed for end-user 9L) for both learners' language development. Intriguingly, the content analysis of the qualitative data revealed positive comments by both users that the game stimulated and motivated both learners to use functional verbal language (Fig.5.1:133 subcategories). This, thereby, gave an interesting indication that the game was enhancing both end-user's language and communication (Fig. 5.1:133 generic categories) and thereby being a therapeutically beneficial intervention for both these learners (Fig. 5.1:13 main categories). This not only corroborated with the user's evaluation that this individualised game would be (and was) therapeutically beneficial for end-user 9L. It further demonstrated to also be of therapeutic value for end-user 19L. The researcher further learnt that for end-user 9L**,** whilst playing the **'Emotions'** game it stimulated and motivated him to spell out words, thereby helping end-user 9L's literacy skills (Fig. 5.2:134 generic categories) thus meeting his educational needs (Fig. 5.2:134 main categories). This again corroborates with the user's evaluation that this individualised game would be (and was) educationally beneficial for end-user 9L.

The researcher learnt from the content analysis of the qualitative data that end-user 17L gave functional verbal responses and imitation of the greeting "Hello" said by a shopkeeper when playing the **'Lets Cook'** game. This suggests strong support that the game encouraged, stimulated, motivated and enhanced his language and communication (Fig. 5.1:133 generic categories) and helped his literacy and numeracy skills (Figs. 5.2:134 and 5.3:134 generic categories). The game met aspects of his needs and corroborated with the user's initial evaluation that this individualised game would be (and was) of therapeutic and educational benefit/value for end-user 17L (Figs. 5.1, 5.2:133 and 5.3:134 main categories).

Interestingly the researcher learnt that the user had not indicated that the game '**Emotions'** developed for end-user 9L had any educational benefits for end-user 19L. The user suggested that he would have therapeutically and educationally have benefited if the game included 'time, [as she felt that this] will bring out verbal [language] because they [can] say the time back, as the learner might be motivated to verbalise the time out loud '. Consequently, the researcher had learnt that the users in School L were delighted that by collaborating in the process their learners had effective therapeutic/educationally individualised games developed for them and agreed to continue to participate further in the investigation (the repetition of Stage I) and include further learners (end-users) from the school. This demonstrated to the researcher the appropriateness of the action research methodology used in this investigation. This process was explained at the Autism Research Conference by Stokes (2006b).

5.6 Overall findings from School L

What was learnt from the 2nd and 3rd AR cycles in relation to the overall findings

The researcher learnt the importance for the individualised games to be evaluated by the development team (for quality control) by using a marking sheet originated by the researcher. This was to reflect and modify the games. The researcher had learnt the importance of using a marking criteria (further quality control) was to reflect upon whether all the games matched aspects of each end-user's needs as stated on the profiles. This resulted in them being appropriately amended before submission to the school.

The games were then duly chosen and evaluated by users as being of therapeutic/educational use before implementation in the classrooms. The researcher learnt positive results that the games enhanced aspects of the diversity of each end-user's language and communication (Fig. 5.1:133 generic categories). This aided the variance of their literacy and numeracy skills (Figs. 5.2:134 and 5.3:134 generic categories). This was achieved from the content analysis of the quantitative and qualitative findings from (telephone and semi-structured interviews (Table 5.17:162).

Table 5.17 What was discovered from the AR 2nd cycle from the results of the telephone interview

Interviewee comment about their learners	Interviewee comments about the CMT/EI process
These end-users had a desire to communicate but it was dependant on the individual's needs. They communicate different things, at different levels that are dependent on their level of autism.	The interviewee claimed that she had not focused on verbal language development, however due to the CMT/EI process there was more discussion around individualism in the School.
They had something to say but they did not know how to say it or were never given the opportunity to say it.	Interviewee was delighted with the development of the personalised games in view of the limited and inadequate information stated on profile caused the lack of involvement of the present staff from the beginning.
They claimed that the school had the responsibility to try and work out what end-users want to say and then 'empower them "to say it" by encouraging them to express themselves through a selection process using choices'.	The Interviewee claimed the importance of the right information being given at the beginning to enable the type of material to be produced. Interviewee's had great satisfaction with the variety and concepts in the games for their learners.
School trying to adopt 'a totally communicative environment'.	The CMT/EI process would give end-users a further therapeutic and educational means of communicating.
The researcher determined from the Interviewee the effective current methods, which were being used in the classroom to enhance each end-user's verbal language skills (Table 5.13:150).	The effective methods such as Makaton sign language would be included in games developed through the CMT/EI process as the researcher had acquired copyright.
The Interviewee stressed the importance of augmented manual methods of communication, which have already demonstrated to be therapeutically effective for some learners.	If these approaches are indicated as being of importance they would be specified in the profiles and then focused upon and included when the game was being developed with the inclusion of text, sound and animation for motivating and stimulating language.

It was further documented in the 4-weekly and 6-weekly diaries, non-participant observations and questionnaires (Table 5.18:163) carried out during the implementation of the games in the classrooms (schools) (2nd and 3rd AR cycles). This strongly suggests that the games were being of therapeutic and educational benefit/value to aspects of each of the learners (end-users) needs (Figs. 5.1:133-5.4:128 main categories).

Table 5.18 Overall findings in relation to games implemented classrooms.

End-users playing on the games	Four-weekly diary entries (June)	Non-participant observations (Sept.)	Questionnaires (Oct)	Six-weekly diary entries (Nov.)	Semi-structured interview (Dec.)
2L **'Learning with Fun'**	Used communicative vocal sounds (Fig. 5.1:133 generic categories	Not participated	A high rating for therapeutic and educational use (Figs. 5.1:133-5.3:134 main categories). A good rating for production	Consistent use of communicative vocal sounds and singing whilst using the game (Fig. 5.1:133 generic categories)	Not carried out for this end-user
9L **'Bright Start'** **Emotions 'Fun Music'**	Nothing stated	Produced verbal and communicative sounds with the use of single words in context, giggles and mmms using 'Bright Start' (Figs. 5.1:133 and 5.2:134 generic categories)	High ratings for therapeutic and educational use and good production of the game (Figs. 5.1:133 - 5.3:134 main categories)	Used spelling and counting whilst playing the games 'Emotions' and 'Fun Music'. (Figs. 5.1:133; 5.2:134 generic categories	Produced further functional speech Verbalising and spelling out words whilst playing 'Emotions' (Figs. 5.1:133-5.2:134 generic categories)
14L '**Tara's Day Out'** **'The Learning Game'** **'Planets game'**	Used communicative sounds whilst playing 'Tara's Day Out' (Fig. 5.1:133 generic categories)	Produced communicative sounds playing 'The Learning Game' (Fig. 5.1:133 generic categories)	High ratings for therapeutic use, average rating for education-al use and a good rating to produce 'The Learning Game' (Fig. 5.2:134 main categories)	Used communicative sounds plus verbal interaction with the user whilst playing 'The Learning Game' (Fig. 5.2:134 generic categories)	Not carried out by this end-user's user

End-users playing on the games	Four-weekly diary entries (June)	Non-participant observations (Sept.)	Questionnaires (Oct)	Six-weekly diary entries (Nov.)	Semi-structured interview (Dec.)
17L '**Buy and Bake'** **'Let's Cook'**	Communicative sounds produced whilst playing 'Buy and Bake' (Fig. 5.1:133 generic categories)	Not participated	High ratings for therapeutic and educational use (Fig. 5.2:134 main categories) and highly commended to produce 'Buy and Bake'	Constant use of verbal language in context (Fig. 5.1:133 generic categories), whilst using 'Buy and Bake' with verbal interaction from the user.	Functional verbal responses and imitation of the greeting 'Hello' said by a shopkeeper in the game 'Let's Cook' (Figs. 5.1:133-5.3:134 generic categories)
19L **'Shapes** and **Dressing Up'** **'Counting** and **Guessing** **Emotions**	Not Participated	Not participated	Not participated	Consistent use of functional verbal language in context and communicative sounds whilst using the game (Figs. 5.1:133 and 5.2:134 generic categories) with verbal interaction from the user	Used functional use of verbal language and communicative sounds whilst playing 'Emotions' (Figs. 5.1:133 and 5.2:134 generic categories)
22L '**Select O Match'** **'Count the animals'** and '**Select-O-Match'**	Produced some communicative sounds and sign language 'Select O Match' (Fig. 5.1:133 generic categories)	Produced some communicative sounds and sign language 'Select O Match' (Fig. 5.1:133 generic categories)	High ratings for therapeutic and educational use and for encouraging the excellent use of verbal language and for providing learning activities for speaking, listening and reading 'Select O Match' (Figs. 5.1:133, 5.3:134 generic categories)	The constant use of communicative vocal sounds and sign language whilst playing with the game, with verbal interaction from the user whilst playing the games 'Count the animals' and 'Select-O-Match' (Figs. 5.1:33-5.3:134 generic categories)	Not carried out for this end-user

5.7 Generic vs. Individualised games according to the user

The researcher ascertained from the literature review (Chapter 2:8) (Parsons et al.; Rahman, et al. 2011; Kovalik and Kuo, 2012) and qualitative findings (School L) that generic games developed for learners with ASD were not taking into consideration their variance and diverse spectrum of needs. Furthermore, learners became bored with manufactured games after three weeks resulting in their loss of 'their attention span' with new games needing to be continuously bought.

The iterative action research process overcame this problem with the volume of different types of individualised tailored games continuously developed.

It was further learnt the importance for the two intakes of students studying this module, in September (over 150 students) and January (over 50 students) to evaluate each other's games and appropriate modify them.

The researcher needed to further reflect, evaluate and modify every game before submission to schools. The AR cyclical method enabled this to continually be achieved over an extended period (Table 5.19:166).

5.8 Summary of what was learnt from the 2nd and 3rd AR cycles (the Initial Application procedure)

The researcher's analysis of the recording and documentation (from Stages I and II (the Initial Application procedure) (Table 5.18:163) of the CMT/EI process) demonstrated that the iterative tailored games developed were of therapeutic/educational benefit/value for the users and their representative end-users from School L.

Many teachers wanted to have the games developed expanded to additional end-users to enable them to also benefit from having individual games developed for them. The dissemination of the results would confirm and validate the process for future academics and researchers.

Table 5.19 What has been discovered from the AR cycles in relation to generic vs. individualised computer games

Generic computer games - according to the users (Parsons, et al.; Rahman, et al. 2011; Kovalik and Kuo, 2012)	**Individualised computer games**
Teaching reading for all developed without taking into consideration each end-user specific needs	Games can be developed for each end-user teaching reading by taking into consideration their needs and reading abilities (Fig. 5.2:133 generic (literacy)).
Influence cognition	Specifically developed for each end-user thereby helping to influence their cognition (Fig. 5.2:133 subcategories).
Ease of use although they tend to time out	Games would be developed to ensure the ease of use for the individual end-users by taking into consideration their diverse spectrum of needs.
Stimulating visual and auditory interface	Stimulating visual and auditory interface would be developed specifically for the end-users needs, likes and interests (Fig. 5.2:134 subcategories)
Accessibility for learners with fine motor skills only	Specifically developed taking into consideration end-users fine and gross motor skills
Software to help speech, language and communication aimed at the average learner.	Games customised to help the end-user with their therapeutic (enhancing their language and communication) needs can be developed dependent on the specifications on profile (Fig. 5.1:133)
Helping to increase vocabulary through their motivation and interest. Generic software does not dominate the users' interest to the extent of 'exacerbating' their autistic difficulties such as their ritualistic, obsessive, repetitive issues, isolating them.	End-user's specific interest as stated on the profiles should be incorporated in the games to stimulate and motivate them. Copyright clearances must be acquired.
New unproved software, which may have been tested on average learners before marketing.	Individualised games developed through the process have proved to be of some therapeutic/ educational benefits as evaluated by the users.
Poor choice of software (games) ending up being unused. Users are unable to try before they purchase these games.	Games developed in collaboration with users solely for their use in the classroom and to the specification stated on the profiles by the user should alleviate ending up being unused, as it would be continuously adjusted.
The computer-generated robotic speech in software has pronunciation and intonation, which is not as clear as human speech and may not be appropriate for some end-users. Sounds incorporated in the software are incorporated for all.	The clarity of sound in games developed will depend on what the user has stated on the end-user's profile.

Generic computer games - according to the users (Parsons, et al.; Rahman, et al. 2011; Kovalik and Kuo, 2012)	**Individualised computer games**
Text in software produced for all without an understanding of each learner's needs by the development team. The software does not take into consideration each learner's needs	Text in the games are developed according to each end-users needs as stated by the users on the profiles, i.e. whether the end-user's prefers static linear or non-linear hypertext, their formatting preferences, colour or monochromic text, size, reading aloud text and animated text.
Some software has been considered as being cold, non-vibrant and non-creative for some end-users	Games can be developed as vibrant and creative as required for the end-user dependent on what the user states on the profiles and according to evaluation.
General non-personalised reward and feedback is often in software such as Correct or ✓ together with negativity such as 'Wrong', or a ×. Sounds for wrong answers are sometimes given. Some do not give any reassurance, encouragement to succeed such as 'try again', or rewards for achievements i.e. clapping, 'well done'.	Personalised reward and feedback through sound, text, graphics and animation can be given. These can be their first name, 'Hello Katie' (in text) that's correct' (with clapping and sign language), Although negativity was incorporated e.g. 'Wrong' and/or 'X" in the first few batches of computer games, these were changed to 'try again', rewards, clapping and 'well done', with arrows pointing to correct answers and using their personal interests as a reward
The software does not take into consideration each individual tactile need.	Tactile needs, difficulties i.e. sensitive, and resistance to close proximity, close contact and touch as stated on the end-user's profiles (Kemp, 2010a) would be taken into consideration for the production of the games.

Consequently, the researcher has learnt that this AR process was demonstrating to be of benefit/value to practitioners. If this were not the case, the process would have been discontinued.

The users (practitioners) would have indicated that they did not wish to continue collaborating with this process due to their time constraints and/or an increase in their workload.

The users might have also evaluated the games as being of poor quality that may have detrimental effects on the end-users and/or not regarding the games as being of therapeutic and/or educational use.

It was necessary to learn if the AR process would be of further iterative use not just as an initial application process with the individual representative school (School L) but also be of use in other representative educational environments. This would show whether practical and/or environmental implementations changed the process, whether other influences enhanced or reduced its iterative use and whether it lead to expansion or abandonment through a pilot prototype of the process.

5.9 Results of the Pilot Prototype of the process

Three random schools (C, W and R) were given anonymous identifiers and were used alongside the representative School L.

What was established from the 2nd AR cycle in relation to the inclusion of School C

The researcher analysis of the qualitative results from the initial evaluation of the chosen games (2nd batch - June 2004) was that The Speech and Language Therapists (SALT) (School C) had concerns regarding 'the level of practical skills' needed by each end-user to play the games. This had not been taken into consideration as a basis for the games. The levels of each end-user's fine and gross motor coordination and levels of skills had not been stated clearly in the medical conditions categories on the original profiles. The SALT team merely stated on the profiles 'Good.', 'Developing' or nothing at all regarding each end-user's thinking, comprehension, literacy, numeracy or physical (keyboard and mouse) skills. Thereby left open to interpretation by the game developers as to each end-users levels of skills achieved. Stokes, (2008a) highlighted this in her published international journal article.

The researcher further learnt that the SALT (School C) was apprehensive that the visual content and presentation, would be a distraction to their end-users. Each end-user's visual requirements were not strongly indicated in the appropriate 'likes'/ 'dislikes' categories or in the additional comments on the profile.

The researcher had strongly emphasised to all the users in the investigation the importance of giving as much information as possible as and the more accurate they were on the profiles a better-suited product would be developed.

The researcher further learnt that the SALT commented that the games did not take into consideration the end-user's language skills. Once again, this was due to the sparse information e.g. 'good sentence structure and use of language,' 'fluent language structure' 'simple sentence structure' 'few words, and sounds' (Fig. 5.1:133; 5.2:134 subcategories) given on the profiles. The profiles, however, requested details such as the number of words, sentences, types of sounds, whether repetitive and in context and their frequency.

The therapists should have indicated any words, letters or sounds each end-user needed help with for pronouncing instead of using broad terms such as 'social use of language' to develop functional use of language' and for some end-users they indicated that it was 'not applicable' or left it blank. The addition of these details would have resulted in the game being individually tailored for each end-user's language skills, in line with the SALTs expectations.

The therapist stated in the evaluation that the games developed leant towards the Asperger end of the spectrum and indicated that the games were pitched at a higher level to their learners. The users omitted to specify their learner's learning difficulties and where on the spectrum they considered each end-user was at on the profiles. Nevertheless, this could have been clarified on the modified profiles. This would have resulted in more appropriate games being developed with the iteration of Stage I of the process.

What was learnt from the 2nd AR cycle with the inclusion of School W

In 2003, the researcher carried out an initial small study using non-participant observation and questionnaires in School W. Qualitative results from the researcher's observations showed that some of the end-users did not seem to enjoy doing individual verbal exercises.

The researcher, however, learnt from observations that pupils using the computer in an informal and natural relaxed atmosphere, resulted in language coming from the computer via the multimedia elements within the game (verbalisation, sound effects, text, graphic, animation).

Furthermore, verbal language came from the very animated and verbally interactive end-users and the user without the necessity of direction by the user or therapist.

The researcher learnt from one of the users that although computer games could be used in the classroom for verbal language development, she did not use any and did not know what types of programmes were available. The process would be able to rectify this by developing individualised games.

The researcher learnt from the results from the questionnaire that some users were claiming that generic software being used was 'only Ok' or 'good for motivating groups of 2/3 end-users who show an interest in the game'. They further claimed that they would be interested in using computer games for verbal language development.

A 2nd batch of games were developed between January-June 2004 and submitted to School W together with a template of an initial evaluation for completion by the users.

The researcher learnt from the qualitative findings once again, there was a limited amount of information stated by the users on the profile regarding each end-user's language and communication and educational details. These were then used as a baseline to develop each individual game (Figs. 5.1:133-5.3:134 subcategories).

The researcher learnt from the findings that all the users (School W) regarded the games as being of benefit/value in helping to meet each end-user's language, communication and educational needs.

This, thereby, demonstrated strong support to the researcher's perception that individualised computer games developed could be of therapeutic/educational benefit/value to users and end-users. (Figs. 5.1-5.2:133-134 main categories).

The researcher learnt from the analysis of the qualitative findings from the questionnaire completed by **End-users 2W's** user, in relation to the game '**Callum'** that the game would help the end-user by encouraging this learner in 'reading simple words' whilst playing the game (Fig. 5.2:134 Literacy categories). The game had taken into consideration, what had been stressed by the practitioner on the profile, as to the importance for the game to assist the end-user's reading skills. This therefore, strongly supports the researcher's finding as to the importance of taking into consideration the diversity of the end-user's language and communication needs. This was in order to develop individualised games, which would aid each learner's reading skills (Fig. 5.2:134 Literacy generic categories) and thereby is of educational benefit/value (Fig. 5.2:134 main categories).

The researcher learnt that for **End-users 4W** - the findings gave an indication that the game **'Learning on a Train'** developed for this end-user would 'encourage the pupil's [language] at least' (Fig. 5.1:133 generic categories). The game was developed as the profile showed that the end-user had an interest in trains and took into consideration his numeracy and literacy skills (educational needs). The user commented that 'the whole idea of a train face [was] being most helpful for the end-user's verbal language development' and helped this end-user's comprehension of hard concepts such as telling the time and understanding of emotion (Fig, 5.2:134 subcategories) through his interest in trains (Table 5.20:172).

The user suggested that 'adult support may lead to instigate [further] language' (Fig. 5.1:133 generic categories). This thereby, strongly supports the researcher's finding as to the importance of taking into consideration the diversity of the end-user's interests, numeracy and literacy needs to develop games, which would be of therapeutic/educational benefit/value to each learner.

Table 5.20 What was learnt from the 2nd AR cycle from the comments indicating the educational use of the game for end-user 4W

Users' comments
'Although limited to three emotions it is a very useful way of dealing with a hard concept. Other emotions could easily be added - I could use an extended level by the addition of a qualifier i.e. he is smiling- we know he's smiling - we know he's happy'
'may aid the teaching' and help in 'reading other feelings or theory of mind'
The game would help this pupil's transferable skills – 'transferring information' which would need to be taught.

The researcher discovered that **End-users 5W's** user gave limited information on this end-user's profile. Qualitative findings from the user's initial evaluation of the '**Bubblegame'** showed some constructive comments and suggestions and claimed the game would benefit/value this end-user's educational needs (Figs. 5.2:133 and 5.3:134 generic categories) and aid their verbal language development (Fig. 5.1:133 generic categories). This was also discussed in Stokes's (2003c) BCS HCI 2003: Designing for Society (Bath) Conference Workshop paper.

The researcher learnt that the user rated the game as being of educationally beneficial and gave positive comments that game was be use for 'word recognition and articulations [as it helped the end-user] with clarification, spelling and naming etc.' (Figs. 5.1 and 5.2:133-134 generic categories).

This therefore, strongly supports the researcher's finding in this investigation as to the importance of taking into consideration the diversity of the end-user's language, communication and literacy needs in order to develop individualised games, which would be of therapeutic/educational benefit/value to each learner.

The researcher learnt that for **End-user 6W** the **'Thomas game'** developed for him was again based on the limited information stated on the profile to help his comprehension, language, listening and reading skills. The game achieved this by encouraging the end-user to recognise and 'name objects and listen to abstract instructions and read words, through written and verbal instructions and imitate through verbalisation' (Figs. 5.1 and 5.2:133-134 subcategories).

This thereby instigated language (Fig. 5.1:133 generic categories) and provided learning activities for speaking, listening and reading (Figs. 5.1 and 5.2:133-134 generic categories).

The researcher further learnt from the constructive suggestions that the game could be of benefit/value for end-user 6W if developers included 'Can you say' or 'you say' (Fig. 5.1:133 subcategories) and/or had 'a turn-taking player 1/2 option added' (Figs. 5.2:133 and 5.3:134). This suggestion would be adopted in the iteration of the action research process.

This therefore, strongly supports the researcher's perception for the importance of taking into consideration the diversity of the end-user's language and communication and literacy needs through the development of individualised games.

The researcher learnt from the user's evaluation of the '**alphabetic'** game developed for **End-users 7W** was of based on limited information provided by them on the profile. The user claimed the game was of good quality and assisted this end-user's language and communication needs (Fig. 5.1:133 generic categories). They proposed that if further games were developed for this end-user that, 'a sound response at the click would increase more vocalisation' (Fig. 5.1:133 subcategories). This strongly supports the importance of taking into consideration the diversity of their language and communication to develop individualised therapeutic games

The researcher learnt from the user's evaluated the game as being of educational use for this end-user (Fig. 5.2:134 main categories) and suggested the addition of 'alphabetical order and names - not phonetic sound', which would be incorporated in the iterative development of the process. This further strongly supports the importance of taking into consideration the diversity of the end-user's literacy needs for the development of individualised games, which would be of educational benefit/value to each learner.

This was presented by Stokes, (2008c) at the Workshop 12 Innovations in measuring accessibility: Initial Process a practical perspective HCI2008 Conference in Liverpool.

The researcher learnt that **End-users 8W** also had a limited amount of therapeutic and educational information stated on the original profile. The '**Farm game'** focused upon helping's comprehension, listening, verbal and reading skills (Fig. 5.1 and 5.2:133-134 subcategories). The user's evaluation of the chosen game claimed that it provided learning activities by encouraging, this end-user to listen and read instructions (Fig. 5.2:134 generic categories) and stimulated and motivated the learner to speak (Fig. 5.1:133 generic categories). The user provided some constructive suggestions for the development of further games such as slowing down the spoken language in the game as 'end-users on the AS need processing time'.

They proposed that the game needed to consist of 'ordering numbers, following spoken and written instructions and tackling labelling as well as nouns with 'animal sounds that they could copy if instructed' (Figs. 5.1:133-5.3:134 subcategories). This would be incorporated in the end-user's modified profile in the iterative process. This demonstrated the importance of individualising games with the diversity of the end-user's comprehension, listening, verbal and reading skills. This has also been briefly discussed in two conference papers by Stokes, (2008c; 2003c).

The researcher learnt that the **'Learning on a Train'** developed for **End-users 4W** was used with **End-user 9W as** both end-users were in the same class and had similar needs. The researcher did not know that the user was going to attempt this until the user returned the evaluation of the game. The researcher learnt that the game did not instigate language or give this end-user 9W the opportunity for verbal language. The user gave positive comments that the game 'encouraged [him] by asking [him] to copy'.

The researcher has, therefore, learnt that all the games developed, chosen and implemented were helping these specific end-users' language, communication and educational needs (Fig.5.1:133-5.3:134). It demonstrated that the users were indicating that iterative further modification and development of the individual tailored games would provide these end-users with games, which would be of further value as a therapeutic/educational intervention. This therefore, strongly supports the researcher's findings as to the importance of using a practice-based AR process by taking into consideration the diversity of the learner's with ASD's therapeutic/educational needs with the development and benefits of individualised computer games.

The overall impression - The quantitative results (Table 5.21:176) demonstrated that nine users in School W evaluated the overall production and construction of the games and gave ratings from 1 poor to 5 excellent and an option to tick Yes or No. The researcher learnt that all the users agreed that the developed games minimised the end-user's memory-load recognition and reduced the need for recall. They were also in agreement that the games matched real-world situations. Five of the users gave the images in the game and many other categories an excellent rating. Importantly, they all felt that with continuous use the games would be of value for verbal language development (Table 5.22:177; Fig. 5.1:133 generic categories).

Four of the users gave the sound in the game a very good rating. No areas were given a poor rating. Any areas which were given a below average rating by any of the teachers were taken into consideration and modified within the iterative action research process. The process was discussed by Stokes (2008c; 2003c) in the Liverpool and Bath conferences.

The pilot prototype carried out using this representative school (School W) demonstrated that at this stage the AR methodology used for CMT/EI process. This suggested strong support for the potential therapeutic and/or educational use and or (benefit/value) for the user and in turn for the end-users (Figs. 5.1:133-5.3:134 main categories).

Table 5.21 The overall rating by School W's nine users on the production of the games.

Quality Games developed for School W	1 (Poor)	2	3	4	5 (Excellent)	Yes	No	Not stated
The consistency of the game	0	0	1	2	2	0	0	4
Does the game cater for universal usability (whether novice or expert)	0	0	0	0	0	4	4	1
Motivation and stimulation of game	0	0	1	4	0	1	1	2
User friendly (Flexibility and efficiency of use for the end-user)	0	0	6	1	1	0	0	1
Does the game provide informative feedback	0	0	1	0	0	8	0	0
The prevention of error has been considered	0	0	0	1	0	8	0	0
Helps end-users recognise, diagnose and recover from errors	0	0	2	0	0	6	1	0
Game permits easy reversal of actions.	0	0	1	0	0	4	4	0
The game encourages the user to be the initiator of the actions	0	0	2	0	0	0	7	0
The reduction of short-term memory needed to use the game (minimises users memory load-recognition rather than recall)	0	0	0	0	0	9	0	0
The game matched the real world	0	0	0	0	0	9	0	0
Provided clearly marked exits (end-user control and freedom)	0	0	0	0	0	8	1	0
Help and documentation provided	0	0	0	0	0	1	8	0
With continuous use could the game be of use for verbal language development	0	0	0	0	0	9	0	0

Table 5.22 Nine users' (School W) rating of the production of the game.

Quality of games developed for School W	1(Poor)	2	3	4	5(Excellent)	Not stated
Images	0	0	3	1	5	0
Text	0	1	5	0	2	1
Sound	0	0	3	4	1	1
Animation	0	1	0	1	6	1
Colour	0	0	2	0	7	0
Layout	0	0	0	3	6	0
Amount of information displayed on the screen (Aesthetic and minimalist design)	0	0	2	1	5	1
Arrangement of information on the screen	0	0	2	1	5	1
Navigation (for example forward and back button)	0	1	0	3	5	0
Terminology used (Simple and natural dialog)	0	0	4	1	4	0
Instructions for the user/ end-user (speaks the users'/end-users' language)	0	0	3	5	1	0
Interactivity	0	0	7	1	1	0

What was discovered from the 2nd AR cycle from the results of Pilot Prototype of the process for School R

School R became the third representative school in the pilot prototype of this investigation using Stage I of the CMT/EI process. The school completed profiles, which were randomly and anonymously distributed to the next cohort of the development team. They used the information stated on the profiles to develop individualised tailored games. These profiles were submitted to the school in June 2004 and the Assistant Psychologist (AP) arbitrarily viewed and evaluated a small sample of eight games.

The researcher discovered in July, 2004 the user (Assistant Psychologist AP) in this school revealed that they were not very content with the 2nd batch of games produced for this school. She was, however, agreeable to proceed further in the investigation and chose six games, which the users felt, matched the end-user for being of benefit/value for these end-users' verbal language.

The user also interestingly suggested that it …would be made easier if [they] could have a copy of each game on a separate disk for each end-user. This had already been tried by the researcher when piloting Stage I (1st AR cycle) of the initial process and was shown to be unsuccessful owing to the storage and handling difficulties with large quantities of CDs.

In July 2004, the AP from School R advised that their sample of end-users had increased by one giving seven end-users for games development and had updated their profiles accordingly. The AP was asked to give her professional comments as to the suitability of the diary template to ascertain the games' potential effectiveness. The researcher discovered that the AP seemed very pleased with the diary template sent to the school remarking that she thought that the 'diary sheets are really good'.

The researcher suggested a trial using screen shot print outs of the games to help train staff and help them become more familiar with the games in its static pre-computerised form. It also would show that the multimedia game was more useful for verbal language when users were familiar with the multimedia elements incorporated in the game.

Researcher learnt that unfortunately, the AP admitted that users had 'not yet used [print outs and initial evaluation sheets] as they had a new team [of staff] and [it was] our priority to be settling everyone in'. She further claimed that:

> she did not feel it [was] necessary to have printouts for each end-user as it will be much more suitable to test the game with the end-users.

What was learnt from the reflection of the 2nd AR cycle from the pilot prototype for the 3rd AR cycle of the process.

The researcher learnt from the results of the pilot prototype that the completion of Stage I of the process and could be used as a predictor as to whether the process and games proved to be of some use. This was demonstrated by the users for the two schools (School W and R) through its iterative development.

Sadly, School C abandoned the process owing to the practitioner's lack of empathy towards this venture with limited responses to phone calls, email messages and letters (poor collaboration). They regarded the 2nd batch of games as being more suitable for high functioning end-users, whereas, their end-users were not 'at the level needed to access and benefit the programmes'. This was omitted from the profiles. If the school had continued this would have been easily rectified through the iterative, modification and updating of the profile (Stage I of the process), considering these concerns within the further iterative AR methodology and development of the games.

The practitioners from School R updated and submitted their profiles in July 2004 and Stage I was again repeated. Although the profiles for School W were not amended its users were happy for the next cohort of students to use the original profiles to develop further games. The researcher learnt from the results of the pilot of the prototype carried out with Schools W and R that the process had potential therapeutic/educational use for the particular end-users. The iterative AR (Stage I) process continued I with the iterative development, by the next cohort of students. The original or modified profiles, together with the evaluations of the previous cohort of the students' work, made by the users, were disseminated to the development team. The evaluations were taken into consideration for developing the 3rd batch of games by December 2004 and were submitted to the schools in January 2005.

The practitioners from School L continued modifying profiles and completing new profiles and had further batches of games (4th-11th) developed for them with the process thereby undergoing a further eight AR cycles.

5.10 Prototype of the CMT/EI process

Schools W, R and F

This next stage in the investigation involved a cohort of students who used an additional representative school, School F, for developing the 4th batch of games. Students were given the profiles from the three schools, Schools W, R and F.

What was learnt from the 2nd and 3rd cycles for the 4th AR cycle

The researcher learnt to disseminate to the next cohort of the development team the evaluations and comments made on the previous cohort of students' work (by the nine users from School W and one user from School R). This together with the completed modified profiles of new end-users from School F resulted in the development of the 4th batch of games between January-June, 2005. Once again to keep confidentiality and anonymity the school was referred to as School F. The practitioners from School F chose five representative end-users, each of whom were given an identification number. The user chose the end-users without giving any indication as to the reason for their choice. It was apparent that all the end-users were male. The researcher, however, discovered that their therapeutic, educational, autistic impairments, together with their likes, dislikes strengths and weakness were shown to be variable. This variation validates the need for individualised tailored games to be developed with a focus on each end-user's autistic, therapeutic and educational needs together with their strengths, weaknesses and dislikes. Their likes (special interests), such as Disney characters and Thomas-the-Tank Engine, were used in the games to give them stimulating, motivating therapeutic and educational opportunities. This therefore, strongly supports the researcher's findings in this investigation as to the importance of taking into consideration the diversity of the end-user's therapeutic/educational needs and interests for the development of individualised computer games. For quality control, one user in School F was given storyboards to evaluate together with an evaluation form to complete. The aim was to enable amendments and modifications to be implemented before the completion of the games and to ascertain from the users whether from their evaluation of the storyboards they considered the games being developed would meet the end-users' needs.

What was learnt from the 4th AR cycle in relation of the evaluation of the storyboards and games by School F.

The researcher analysis of the quantitative data of the storyboard was that the users evaluated the content of the games as:

- conveying useful educational information, instruction and/or direction (Figs. 5.2 and Fig.5.3:134 main categories).
- most of the games would help to present, share, clarify and reflect on ideas and help their social imagination and was going to be aesthetically pleasing (Fig. 5.2:134 generic categories).
- the games would provide the end-users with a stimulating language environment (Fig. 5.1:133 generic categories)**.**
- more than half of the games would instigate more verbal language if used in pairs and/or group work.
- the user rated over three quarter of the games from the evaluation of the storyboard as being of educational use (of benefit/value) for providing learning activities in speaking, listening and reading
- the style of the language used in the games was appropriate for the end-users (Figs. 5.2:134 and 5.3:134 generic categories).

The researcher ascertained from the 4th AR cycle that the users made many positive comments when evaluating the storyboards such as for…

End-user 1F – who had interest in beetles, this was going to be implemented in the game '**Polly's Mix Match'** and would 'give the learner the opportunity to work, say/record what they already know about' (Fig. 5.2:134 generic categories).

End-user 2F - the user liked 'the children's voices' in the game '**Welcome to Mickey'** as the game took into consideration that the end-user needed a 'multisyllable word blending game' (Fig. 5.2:134 generic categories) and used his interests in Mickey Mouse and jigsaws.

End-user 4F -The user's had positive evaluation of the game '**Game2'** as it used the information on the profile that this end-user needed to learn to tell the time and used digital and analogue clocks in the game.

The user made positive comments to another game '**Egyptian Quest'** that the game matched the profile that this learner would benefit from a game, which helped him with prediction, decision-making and enhancing his listening skills through appropriate voices, music and visuals (Fig. 5.2:134 generic categories). The researcher, therefore, ascertained from the qualitative evidence strong support that the 4th batch of games for School F's end-users would be of therapeutic beneficial as the users stated that 'all the games would make language development fun' and be of educational benefits/value (Figs. 5.1:133-5.3:134 main categories).

5.11 Iterative use of the process

What was learnt from the 4th AR cycle.

The researcher learnt that School F's users evaluated the games and gave an equal amount of concerns and positive comments. With regard to Schools W and R, although neither school updated or modified the profiles or evaluated any of the developed games. The researcher learnt that both school wanted to the researcher to continue to use their end-users' original profiles and were pleased to be receiving and were looking forward to receiving continuous additional games with the AP from School R expressing their gratitude for the contribution the games had made. The researcher therefore learnt that Stage II was a predictor and that the process could be abandoned (as in School C) or, continued (as shown with Schools L, R and W) with the users evaluating the games developed as being of therapeutic/educational use for some end-users with ASD.

The 5th AR cycle - 5th batch of games by School CC and H/S

A further representative school, School CC and a Home/School (H/S) were approached and were eager to join the investigation. They received an extensive blank template with far more categories. Table 5.23:183 shows a summary of the extended profile (Appendix 5:183).

Table 5.23 Summary of extended profile (Appendix 5:183)

Age
Gender
Ethnic origin
Medical needs
Visual/Auditory/Fine and Gross Motor difficulties
Where on the autism spectrum is the learner?
Social Interaction
Ability for the rigidity of thought and social imagination
Behavioural difficulties
Sensory difficulties
Ritualistic and/or obsessive behaviours
Verbal or non-verbal language used
Echolalic
Communicative sounds used
Comprehension and developmental levels
Sign language and/or gestures used
Facial and/or body language used
Symbols (PECS, TEACCH) used
SALT already being used
Reading, Writing and Math's levels
The curriculum being followed in school
Educational areas for consideration
Computing and ICT skills
Modalities preferences (Tactile/Visual/Auditory)
Multimedia element preferences (Text/Sound/Graphics/Animation/Video)
Play and Interests
Likes/Dislikes
Strengths/Weaknesses

Stage I was repeated in January-June 2005 using School CC and H/S once again showing the cyclical action research approach used for this investigation. The other schools were not included due to a limited cohort of students for the development team to devise the 5th batch of games. It can be seen that the end-user who participated in the investigation was from the H/S environment and was a verbal 5-year-old male verbal end-user with ASD and a diversity of therapeutic and educational needs. The 5th batch of games was submitted to the School CC and H/S in January 2006.

5.12 Stage I of the prototype procedure –Schools N and S

What was learnt for the 6th-11th AR cycles.

The practitioners from School N used nine end-users from 2006 (6th batch) this increased to 15 end-users by 2010 (9th-11th batches of games) (Table 5.2:138).

The researcher learnt that the practitioners wanted to continue participating with this process. This was achieved over four years. The researcher learnt from the continuous verbal and written annual positive feedback from the head of the autistic unit (user) that their end-users were educationally benefitting from the batches of games being developed. This gives strong support for the researcher's findings in this investigation as to the importance of collaboration with practitioners in computer games development. It also demonstrates the effective use of the AR methodology and the importance of establishing the diversity of each end-user's needs and interests to develop therapeutic/ educational computer games as an aid for the user and their end-users with ASD. The head of the autistic unit from School N went on to become the Deputy Head-teacher of School S. He then contacted the researcher asking if his new school could also participate in the investigation in 2010.

School S is a primary moderate learning difficulties (MLD) school for 75 end-users in the age range 4 to 11 years. The Early Years - Autism Provision in the School has two infant classes for end-users on the autism spectrum and associated learning difficulties. The practitioners consider these end-users to be full members of the school and offers them access to the complete range of educational and social opportunities available to all pupils in the school. The practitioners stated that 'priority is given to language development, social interaction and the explicit teaching of appropriate social behaviour and life skills' (School website) and the users from this school completed 32 end-users' profiles. This demonstrates the on-going cyclical action research methodology used.

The 12th (September 2010) - 14th (June 2013) batches of games were developed for School S's end-users. Profiles were modified and Stage I of the process was continually re-runs for four years.

What was discovered from the 12th-14th AR cycles

This gave strong support for the effectiveness of the AR methodology used in this investigation. The researcher further learnt that practitioners were content to be fully involved in a continuous collaboration with the project.

The Deputy Head teacher of School S visited the university annually to give the students more information about each end-user and to pass on comments on the previous cohort of student's attempts. This allowed the students to equally raise any questions about the end-user they were working on with him.

The researcher learnt that the practitioner's satisfaction with the games, which had been developed and were being used in his school and proving to be therapeutically/educationally beneficial for these learners. He also annually evaluated the games, which were being developed in the classroom and gave the students verbal constructive comments for improvement. This demonstrates how effectively academia and society can work together resulting in the improvements of therapeutic/educational computer games through the iterative interactive process.

The completion of the extended profiles resulted in permission gained for the end-user's first name to be incorporated throughout their game to further personalise the games. The games were increased to four activities e.g. literacy skills, numeracy skills, social skills and communication skills. Each of the activities having four levels with the first level being the easiest. In addition to the investigation, whilst working with School L the researcher proceeded to establish how non-computerised multimedia therapeutic/ educational interventions were being monitored and used by a comparable group of end-users from School L. This resulted in the researcher's publications (Stokes 2014a; 2014b).

5.13 Summary of the Prototype procedure

All nine educational establishments underwent Stage I of the CMT/EI process. Eight educational establishments underwent Stage I numerous times extending to new end-users. Schools L, R, W, F also underwent Stage II of the process. This strongly supports one of the objectives, which was met by enabling the process to be carried out with large groups of participants on an iterative basis (Table 2.17:63). This was achieved in order to address the gaps and concerns ascertained from the literature review findings (Table 2.16:62) and answered the research questions (Table 2.18:63)

A summary of what was learnt from the prototype procedure

The researcher learnt from the recording and documentation of the results from the prototype procedure that the iterative individualistic games were of therapeutic/educational benefit/value for the users and their end-users. The literature review (Thornbury, 2005 and Kovalik and Kuo, 2012) highlighted that the practitioners were claiming that products were not being therapeutically/ educationally developed and effective for them and their learners (Chapter 2:8). This, and the aims of the investigation, which was to establish if the therapeutic and educational use of individualised tailored computer software developed for practitioners has been met in this practice-based Evaluation AR process.

The maintenance of the process was demonstrated by users requesting to expand the project to additional end-users to enable new end-users to also benefit from having individual games developed for them. Games were chosen and implemented in classrooms by 49 practitioners (users) in eight educational establishments evaluated the games as being of therapeutic/educational benefit/value for their 464 learners with ASD (end-users) over an extended period of time. The maintenance of the process was also shown with the cyclical process continuing over 14 cycles. This investigation demonstrated the iterative results from the initial application and prototype procedures (Stages I and II of the process). The dissemination of the results confirms and validates the process for future academics, developers and researchers. It further demonstrates the continuous success of a module and assignment with cohorts of (over 2,000) students developing individualised computer games over ten years.

*What was learnt from the AR cycles in relation to student's motivation and raising their standard of work***.**

To answer the research question 'What are the barriers and opportunities of such a process?'. The investigation demonstrated an increase in student's motivation and standard of student's work. The students completed questionnaires and gave many positive comments regarding the assignment being very motivating as they were producing a product for very real learners and not just to gain a grade.

Students claimed that they wanted to do a 'good job' as they wanted their end-users to benefit educationally from their product (Appendix 2:268). This further answered the research question that the CMT/EI process therefore enhanced the development of computer games with the development of individualised games for these learners. This showed a raise in their motivation and the standard of work they submitted. (Appendix 2:268). A few students went on to voluntary or paid work for the disabled society. Some were motivated by studying their end-user's disability and carrying out this assignment, that they continued their academic studies by choosing to relate their products, final year dissertations, Masters and PhD thesis to disability. Some students became Student Representatives.

From 2007 (for six years), some students became Student Teaching Assistants (SLA) to assist and advice further cohorts of students with the development of years. The SLA project was created and piloted by the researcher and is still implemented in the home and international university campuses.

One student proudly demonstrated and presented her developed game in two of her graduate job interviews for Hewlett Packard UK and Microsoft. She informed me that the feedback from the interview was that they were very impressed by her attempts at developing a useful product for someone in society with a disability and that they both made her an immediate job offer.

This investigation answered the research questions (Table 2.13:63) by demonstrating that the CMT/EI process gave university students the opportunity to undertake a real assignment of developing computer games for real learners in the autistic community (Appendix 2:268).

This was through this practice-based evaluation action research adopting a diversity of each end-user needs and used this as a baseline for a Design-For-One approach, with cohorts of university students developing individualised computer games as part of their studies and for real autistic learners.

What was learnt from the AR cycles to demonstrate the replication of the process

This investigation, therefore, argues that by the replication of this method, through three main iterative circular phases (Preparation, Organisation and Reporting) future advanced studies would equally be able to provide useful findings and contributes to new knowledge. The researcher explains the resume of the process, which others could use as guidelines/protocol to follow:

Preparation – The researcher learnt the importance to contact schools and give a full explanation of the process to users. Prepare the development team on how the module and assignment is to be run and assist their understanding of concepts and areas outlined in profiles, the theoretical aspects of multimedia, through lectures and seminars. When planning it is important to be mindful of the user's workload, time constraints and school holiday periods and the student's semesters (terms) and their computing skills and abilities.

Organisation – It was important to produce and submit permission letters for parents and send blank profiles to schools. Make sure schools return completed profiles. Distribute randomly the completed profiles to the development team. Assist the development team in the production of a research report, the development of storyboards, print outs and games based on the profiles.

Evaluation – It was important for quality control with the evaluation of each game by the development team. The researcher/developer equally needs to evaluate the computer games and included all the games for each end-user onto one or two disks before submission to schools. Blank initial evaluation sheets, diary templates and constructed questionnaire and interview questions needs to be submitted to schools. Ensure the documents are completed and evaluative feedback is returned to the researcher/developer. The researcher/developer needs to perform non-participant observations of the end-users playing the games in the classroom.

Reporting – The researcher suggests a content analysis (Figs. 5.1-5.3:133-134) of the quantitative and qualitative findings from the data arising from the completed initial evaluation sheets, diaries, questionnaires, transcribed and verification of interviews and non-participant observations needs to be carried out. The documented and recorded findings need to be disseminated through talks, poster sessions, refereed conferences, journals and book chapter articles and to all the participants in the investigation.

Table 5.24 What was learnt from each stage of the AR cycles, in relation to the process and the product.

Process	What was learnt	Product	What was learnt
1a. Approach and discussion with schools.	To gain schools empathy for the project. For schools wanting to continue to be involved. The involvement of new schools.	1b. Design/ amend Module and Assignment	The necessity for on-going modification of module and assignment
Plan, design/amend documentation:… Hierarchical Task Analysis (HTA). - Timescale. - Template profile. - Evaluation sheets, - Diary sheets, - Observation sheets, - Interview questions, - Questionnaires	The necessary for amendments to the documentation. Timescale needs to be carefully considered for the development of games (university term time) with the school term and the practitioners involvement)	Plan, design/ amend documentation Timescale Feedback forms Plan and describe to students:… - Assignment - Completed profiles - previous students' games - Storyboards - Games	Cohort of students would need to be aware of the feedbac from schools on previous students games. Encourage students to evaluate each other's games to enable modification to improve the quality of the games
2a. Carry out pilot studies. Submit documentation to practitioners:… - template profiles - storyboards + evaluation sheets - print outs + evaluation sheets - evaluation sheets for games - diaries - questionnaires	Further pilot studies are necessary. There is a need to continually carry out alteration to template profile. Practitioners need to continually encourage practitioners in the evaluation of the games.	2b. Implementation of Module and Assignment. - Distribution of completed profiles to students. - Provide students with examples of games. - Give students advice and guidance on:… - research - profiles - storyboards - games	The module and assignment needs to demonstrate to be of success. Need to develop further examples of games.

Process	What was learnt	Product	What was learnt
Receipt of practitioner's completion of new + modified profiles and above documentation from practitioners. Carry out Interviews and Non-Participation Observations	Need to continually encourage practitioners to fully complete the profiles with as much information as possible.		
Modification of documentation Analysis and evaluation of :… storyboards and tested games. Completed diaries Interviews Questionnaires Non-participant observations Receipt of new + modified completed profiles	Further modification of documentation is necessary. Practitioners need to be encouraged in the completion of qualitative and quantitative methods as some may only be interested in just completing an initial evaluation of the games only. Encourage schools to modify profiles and extended to new learners.	Testing, evaluation and modification of games before submitting to schools.	This needs to be continued with the on-going process

5.14 Conclusion

The investigation highlights what has been learnt from each of the evaluation AR cycles (based on Chart 3.1:85) in relation to the product process and the product (Table 5.24:189). The researcher learnt from adapting and adopting Elo and Kyngäs's, (2008) content analysis (Figs. 5.1-5.3:133-134) of the quantitative and qualitative methods (1^{st}-4^{th} AR cycles) that it helped to answer the research questions (Table 2.13:63) with the objectives (Table 2.12:63) and aims of the investigation being met.

The researcher learnt from Stage I (Planning, collection, organisation, design and development) of the CMT/EI (Initial Application procedure) carried out with School L and the pilot prototype with, Schools L, C, R and W that the games were of therapeutic and educational use (1^{st}-3^{rd} AR cycles).

From the prototype procedure with (Schools F, CC and H/S, N and S), the researcher learnt from the users from School F the evaluation of the storyboards and games the potential therapeutic and educational benefits of the games (4th and 5th cycles). The researcher learnt from further batches of games (6th-10th) submitted to School N (2006-2010) and (11th-14th) to School S (2010-2014) (6th-14th AR cycles) positive evaluation as to the therapeutic/educational benefits and value of the games.

The researcher and the development team learnt from annual visits from the Deputy Head teacher of School S to university constructive suggestions whilst the games were being developed. This enabled the students to ask questions about the end-users. He further articulated to the researcher and the development team, that on behalf of his staff, the games developed were being used in his school and were proving to be therapeutically and educationally beneficial to all his learners.

The researcher learnt that using university students to undertake a real assignment to produce multimedia games for real end-users increased the student's motivation and raised the student's standard of work.

The researcher learnt that the CMT/EI process, used in this investigation, was of therapeutic/educational benefit/value for the users and their learners on the autism spectrum through:

- the on-going collaboration and input of large groups of practitioners
- using a Design-For-One approach
- for the development of individualised computer games,
- developed by students in higher education,
- for learners with ASD,
- in numerous educational establishments,
- over an extended period of time.

The AR (1^{st}-14^{th}) cycles and results from this investigation gives strong support that the gaps and concerns from the literature review findings (Table 2.11:62) had been met by achieving the objectives (Table 2.12:63). The research questions (Table 2.13:63) were answered and the aims of the investigation, 'to establish if the therapeutic (language and/or communication) and educational (literacy and numeracy) use of individualised tailored software', were met.

Chapter 6
Discussion and Conclusion

6.1 Introduction

The purpose of this chapter is to compare the findings from the areas examined and discussed in the literature review (Chapter 2:8) with the results (Chapter 5:129) from this investigation. The chapter contributes to addressing some of the gaps and concerns (Table 2.11:62) from the literature review findings through the objectives (Table 2.12:63). This was to support or contradict the research questions (Table 2.13:63) and to conclude if the aims of the investigation, the therapeutic (language and/or communication) and educational use of individualised tailored software is being met. The chapter achieves this by revisiting and considering each objective individually.

6.2 The first objective - collaboration

The research findings highlighted concerns (Table 2.11:62) that studies were not appreciating the importance of collaborating with the learners' multidisciplinary team of users (practitioners), as verified in Barry and Pitt's, (2006) studies. Analysis by this investigation revealed contradicting levels of liaison and collaboration between teachers and therapists (SALTs).

This concurs with Law et al. (2002) regarding the importance of frequent collaboration of speech and language therapists with educationalists (Reported by Stokes, 2003d).

This investigation has answered the research question as to 'How does a CMT/EI process enhance the development of computer games for learners with ASD?'. This was achieved through the implementation of an iterative collaborative, holistic, Design-For-One approach. The first objective was met through a continuous rapport and collaboration with 49 practitioners (users) from nine educational establishments, over an extended period of time, through action research cycles of the process.

The researcher's years of parental experience helped her to understand the context of the research. Similarly, her knowledge and understanding enabled her to achieve a good rapport with practitioners (users) to gain their involvement in the investigation on an iterative basis.

This supported Herr and Anderson's, (2005) claim as to the importance for researchers to draw upon their own experiences.

The collaboration of the practitioners (users) were achieved using a careful iterative systematic technique involving the user's appraisal of their learners' (end-users') needs through:

- choosing end-users to participate in the investigation.
- completing learner profiles to highlight each end-users' combination and diversity of needs etc.
- evaluating storyboards, print outs and games for therapeutic/educational value.
- evaluative feedback leading to adjustment and further development of personalised tailored games.
- completion of further new and modified existing profiles
- evaluating and choosing to implement the games in the classrooms which they considered to be of therapeutic (for enhancing language and communication)/educational (for literacy and numeracy skills) use for each end-user.
- testing, monitoring and evaluation as to the effectiveness of the games from the way each end-user played the games in the classroom through the completion of evaluation sheets, diaries, questionnaires, interviews and observations.

The researcher/lecturer used an iterative collaborative approach with cohorts of students and academics (development team) through the researcher's origination and development of a module and assignment.

This resulted in bringing society and autism awareness into academia with the development of individual computer games for real learners (end-users) with ASD in society. This further resulted in the findings (Chapter 5:129) that practitioners regarded the individual computer games of benefit/value for their learners (end-users).

Through successfully adopting an iterative collaboration with practitioners, the first objective had been fulfilled by resolving one of the gaps (Table 2.11:62) in the literature review findings. The research questions 'How does a CMT/EI process enhance the development of computer games for learners with ASD?' and 'What are the barriers and opportunities of such a process?'. The research questions were answered and the aims met through the implementation of an iterative collaborative, holistic, practice-based Design-For-One action research approach (Table 2.13:63).

6.3 Second objective - Determining end-user's requirements.

The researcher developed a template of a profiling document for completion by the users about each learner. This provided a baseline for developing individual games by understanding the diversity of needs.

Language and Communication (Therapeutic) needs

The analysis of the interviews with practitioners of the representative School L (Chapter 5:129) highlighted that the learners generally wanted to communicate but did not necessarily know how to do so. The games were therefore developed taking the end-user's language and communication (therapeutic) needs in mind. This supports Volker and Vaz, (2010) studies as to the importance to ascertain each learner's communication needs.

Literacy and Numeracy (Educational) needs

The researcher's experience and perception concurs with Miller and Eller-Miller, (2005) and VanBergeijk, et al. (2012**)** studies, that some learners' diverse autism difficulties and speech and language problems were not being taken into consideration alongside of their educational needs in schools.

This resulted in poor educational learning outcomes and behavioural difficulties. To address this the process needed to take into consideration the variance of each learner's autistic, therapeutic and educational needs and approaches already adopted in schools. This would have been stated on the completed profiles and used for developing appropriate literacy and numeracy computer games for learner's to use in the classroom.

This, thereby, concurs with Macaskill; Beaver, et al. (2005) and Sansosti, (2010) that language is best learnt if learners are placed in a naturalistic social situation (e.g. the classroom) using individual or a combination of approaches (Reported by Stokes, 2003a).

Discussion on Pilot of Stage I – Initial Application procedure – 1st AR cycle of the process in relation to determining end-user's requirements**.**

The end-user's requirements were determined by the completion of profiles by the users. This resulted in the development of the 1st batch of computer games, which were stored on discs and submitted to School L. The investigation reflected upon and learnt from the 1st AR cycle of the process (the pilot of Stage I of the Initial Application procedure) the importance for the games to be stored on a limited media. This resulted in the games developed for each end-user stored on single discs. This, thereby, rectified the storage, handling, time consuming and mundane difficulties claimed by the practitioners from School L when they received 150 CDs (e.g. 5 or 6 games stored on individual CDs) from the 1st batch of games developed for each of the 27 end-users.

Discussion on Stage I – Initial Application procedure - 2nd AR cycle - profiles

The researcher had compiled a template profile purposefully with restricted categories identified from the literature review (Chapter 2:8) and due to her knowledge that the practitioners had a limited time constraints. The purpose was also to gather data on the diversity of each end-users' therapeutic/educational individual details and needs (Chapter 2:8). The completed profiles, by the practitioners, would be used as a baseline for developing customised fun therapeutic/educational computer games for each end-user.

Unfortunately, this resulted in the practitioners equally giving limited information on the completed profiles for games. The researcher reflected upon this and learnt through the continuous modification of template profiles over the 3rd -14th AR cycles of the process, the diverse individuals' needs of each end-user can be gained from the inclusion of more categories to an extensive template profile.

Discussion on pilot of Stage II–Initial Application procedure–2nd AR cycle of the process-therapeutic benefits/value of the 2nd batch of games for School L

The importance for helping learners to improve their verbal, gestural and symbolic communication was achieved through the completion of the categories on the profile, by the user, thereby concurring with Duffy and Healy (2011) studies.

The analysis of the qualitative and quantitative findings from initial evaluation sheets and piloted diaries were based on the monitored and recordings by the users (and a non-participant observations carried out by the researcher) on the chosen games implemented in the classroom. These games were from the batches developed from the 2nd and 3rd AR cycles of the process (Initial Application procedure). It demonstrated that the games enabled the learners (end-users) from School L to use verbal, communicative sounds and non-verbal communication (sign language) (Fig. 5.1:133 subcategories) and was therefore indicative of the therapeutic benefits for their end-users. An example of this can be seen with the games developed for end-users 2L and 14L, resulting in stimulating and motivating these end-users to produce communicative vocal sounds and signing. End-user 2L's user further envisaged that by using the game in different ways it would increase vocabulary and enable more sounds.

The results of the Initial Application procedure – 2nd AR cycle of the process revealed that according to School L's users the 2nd batch of games developed revealed that although limited information was stated on the profiles the games were indicative of being of therapeutic/educational use for their particular representative end-users.

Discussion on Pilot of Stages I and II – the pilot of prototype procedure – 2nd AR cycle of the process - 2nd batch of games.

Stage I of the process was further piloted as a prototype procedure with three schools (Schools C, R and W) to alleviate the limitations of using a single school.

It was further to ascertain if practical and/or environmental implementations changed the process or whether other influences enhanced or reduced its iterative use, which would lead to expansion or abandonment. It was also to determine if other schools were interested in having multimedia games developed for practitioners (users) and their learners with ASD (end-users), were happy in collaborating with the process and were in agreement to complete the profiles in full, for the development of the 2nd batch of games.

School C

Unfortunately, School C withdrew from the process (Chapter 5:129). The qualitative results revealed, from the initial evaluation of the chosen games from the 2nd batch of games, indicated that their Speech and Language therapists had some concerns as to their end-user's practical ability playing the games. The visual content of the games they did not take into consideration the end-user's language skills. They felt the games leant towards the Asperger end of the spectrum and indicated that the games were pitched at a higher level to their learners. Unfortunately, these areas were not highlighted on the profiles. These areas could have been reflected upon and modified with the rerun of the process.

School W

The template profiles with limited categories was sent to School W. Equally, School W submitted limited information on the profiles. Nevertheless, the analysis of the qualitative and quantitative findings revealed that the users from School W's initial evaluation on the games developed from the 2nd AR cycle of the process demonstrated that the games were of therapeutic and educational benefit for their end-users.

School R

Interestingly the user from School R suggested that it …would be made easier if [they] could have a copy of each game on separate discs for each end-user.

This had already been tried and was unsuccessful (Stage I of the Initial Application procedure with School L) piloted with the 1st AR cycle, owing to the storage and handling difficulties with large quantities of CDs. The analysis from the qualitative findings revealed that the user from School R's initial evaluation of the 2nd batch of games were therapeutically of benefit/value for them even though the games were based on limited information on the profiles.

The results of the pilot of the prototype – 2nd AR cycle of the process revealed that according to the users the 2nd batch of games developed for the end-users from Schools W and R (based on limited information on the profiles) revealed to be of therapeutic and educational use for their representative end-users.

Discussion on Stages I and II of the Prototype procedure - 3rd AR cycle of the process – 2nd and 3rd batch of games.

The analysis of the quantitative and qualitative findings (from the re-piloted weekly diaries, telephone and semi-structured interviews and questionnaires) demonstrated that the users from School L were claiming an improvement in the games. This could have been due to the completion of modified template profiles.

Qualitative and quantitative findings (Chapter 5:129) showed that School L 's users claimed the games (2nd and 3rd AR cycles) gave their end-users rich meaningful literacy experiences by being educationally beneficial for their end-users with language and communication difficulties. This was through encouraging them to verbalise the words and sentences from the text, graphics and sounds. From the analysis of the results (Chapter 5:129) e.g. pre-readers end-users 2L and 22L playing the games '**Learning with Fun'** and '**Select O Match'** made verbal communicative sounds and signing objects and colours.

This process, thereby, concurs with LaBarbera and Soto-Hinan, (2011) by giving end-users, with language and communication difficulties, a rich meaningful literacy experience and not just regard them as non-readers. The results demonstrated the user's (from School L) evaluation of the batches of games (3rd AR cycle of the process), implemented in the classroom, were of therapeutic/educational benefit/value for the learners. An example of this can be seen with end-user 9L not only producing functional verbal language, using single words in context and communicative vocal sounds but also demonstrating an enjoyment by verbalising and spelling out words whilst playing the spelling and counting games, thereby appropriately meeting their therapeutic/educational needs. This corroborated with the user's initial evaluation that the game '**Emotion'** would be therapeutically and educationally beneficial for this end-user.

School W's users gave positive evaluation that the 3rd batch of games developed (3rd AR cycle), would be of value for the majority of their learner's verbal language development for their learners (end-users). The analysis of the quantitative findings (Chapter 5:129) demonstrated that the users rated the games as being of educational use for their learners. An example of this can be seen with a user claiming that the game **'Bubblegame'** developed for end-user 5W had educational use for 'word recognition and articulations [as] it clarifies spelling and naming etc.*'*. This demonstrated that this end-user's educational needs had been correctly determined from the completed profiles and appropriately incorporated in to their individualised game, thereby meeting their educational needs. The analysis of the qualitative findings in relation to School R revealed that the process was of therapeutic/educational use for the particular representative end-users.

Discussion on Stages I and II – the Initial Application procedure – 4th-11th AR cycle of the process -4th- 11th batch of games for School L

The users from School L equally continually revised and completed modified profiles through a further eight cycles. This resulted in positive annual verbal evaluation that the (4th-11th) batches of games continually improved and was evaluated by the users as being therapeutic/educationally of benefit/value for the learners (end-users).

Discussion on Stages I and II – Prototype procedure – 4th and 5th AR cycles of the process – 4th and 5th batches of games for Educational establishments R, W, F, CC and H/S.

The results (Chapter 5:129) from this investigation demonstrated from the 2nd- 4th AR cycles of the process, that the users from School W agreed that they would use the individual games to enhance their learner's language and communication and literacy and numeracy skills. This again demonstrates that School W's end-user's therapeutic and educational needs had been appropriately been determined and met by the games developed.

The qualitative analysis of the findings, from School F's evaluation of the storyboards (4th AR cycle) indicated the users' approval of the style of language within the games. It demonstrated that the games could assist their learners' verbal language development and could instigate more verbal language if used by pairs and/in group work as it made language development more fun. The analysis of the quantitative findings from the evaluation of the storyboard, by School F's users, indicated that the 4th batch of games being developed (4th AR cycle) built upon what the end-user could already do resulting in the games providing the end-user with a stimulating language environment, whilst conveying useful educational information. The users envisaged that the games would help the end-users express their feelings, experiences and/or opinions as well as help them present, share, clarify and reflect on ideas whilst stimulating their imagination and interests. The games would, thereby meet the educational needs of their end-users by providing them with learning activities in speaking, listening and reading. This thereby indicates that their diversity of needs had been determined from the profiles and appropriately met in the games developed.

The users verbally indicated that the games (5th AR cycle) were of therapeutic/educational benefit/value for their end-users, with their end-user's therapeutic and educational needs appropriately determined and met by the games developed. Two educational establishments CC and H/C completed profiles and received computer games (5th batch), unfortunately, the users did not evaluate the games.

Discussion on Stages I and II – Prototype procedure – 6th – 14th AR cycles of the process – 6th – 14th batches of games for Schools F, N and S.

School F continually completed profiles resulting in the 6th batch of games but unfortunately the users did not evaluate the games.

Batches of (6th-10th) storyboards and games were developed for School N. This resulted in on going verbal positive feedback that the end-users' needs had been appropriately met, with the therapeutic/educational benefits/value of the games.

School S requested to be involved in the investigation from 2009-2014. They received an extended template profile. They continually verbally indicated positive comments that the batches of games developed (6th-14th AR cycles) were continually very therapeutic and educationally beneficial for their end-users. They further indicated that they had not collaborated on the development of any generic computer games or found any off-the-shelf software which had ascertained the diversity of their learner's autistic, therapeutic and educational needs, resulting in the development of effective individualised games for their learners. This corroborates with research findings (Vanderborght et al. 2012) that there was no evidence that generic computer games were being developed and used in classrooms, as a bespoke therapeutic/educational intervention, which took into consideration the variance of these learners needs. There is further evidence from the users in School W that they were not using generic commercialised games for individualised language development but were interested in using individualised games for therapeutic/educational benefits/value.

The therapeutic/educational effectiveness of these individualised games could be due to each end-user's diversity of therapeutic/educational needs successfully taken into consideration, demonstrating that the games were matching each end-user's language, communication, literacy and numeracy needs stipulated on their completed profiles. Research findings (Jordan, 2008) claimed the importance of building upon each learner's educational achievements in the classroom environment.

The environment

End-user 17L's enjoyment of cooking and baking was extracted from the profiles and used in the '**Buy and Bake'** and '**Lets Cook'** games (2nd and 3rd AR cycles). This resulted in demonstrating that the games were of therapeutic/educational benefit/value. This thereby, concurs with Roberts et al. (2011) that many learners performed best in an environment that built on their skills and interests whilst accommodating their special needs.

The analysis of the results (Chapter 5:129) indicates that the classroom uses of computers for language development have resulted in speech and communicative vocal sounds (giggles and laughter) from the end-users playing with their individualised games. This concurs with past teaching interventions (Kemp, 2010b; Berk, 2011; Heimann and Tjus, 2011a and 2011b) (Reported by Stokes, 2003a-2003e).

The investigation recognised the great importance the environment and surroundings had for increasing language. This can be seen with the end-user more stimulated and motivated when surrounded by language in a predictable, routine, interactive playful classroom environment. An example of this can be seen with the user (end-users 4W and 9W) claiming the game **'Learning on a Train'** (3rd AR cycle) encouraged these learners to verbally repeat the words. This, thereby, indicated that the game met both end-user's therapeutic and educational needs. The study would have benefited from the input of a multidisciplinary team, as suggested by Macaskill, (2005) and Sanches-Ferreira, et al. (2013).

Users Input and the curriculum

This investigation used mainly teachers as the users (practitioners) due to the absence of SALTs (Chapter 4:88). This study, however, acknowledged that it would have benefited from the relevant information on their Individual Education Plan (IEP), which had been compiled by the multidisciplinary team. This could have been incorporated into their profiles, thereby, giving a more complete baseline, e.g. strategies, targets and concepts that needed to be met.

The process, therefore, focussed on each end-user's diversity of needs whereas, the literature review findings (Chapter 2:8) (Jones, et al. 2009 and Equals, 2010) demonstrated that interventions, past studies and the National Curriculum were not taking each individual learner's diversity of needs, their tactile, visual and/or auditory preferences, computer capabilities and their areas of strengths, likes, dislikes and interests were taken into consideration. The investigator's experience and perception was that the National Curriculum can be too demanding for some learners due to learners' diversity of needs. This concurs with Jones, et al. and Critchley, (2009) and Hornby, (2012) studies.

Conversely, specific educational areas of difficulties (e.g. telling the time, money, shopping) were successfully addressed by the games using each learner's interests, e.g. Baking, Disney, Thomas-the-Tank Engine. The study agreed with Neuwirth, (2004) and Roberts et al. (2011) that using each learner's interest or a thematic approach gave the learners their own meaningful curriculum and helped reduce their behavioural problems and increase their capacity to learn, communicate and interact with others. Consequently, the individual games, (2nd and 3rd AR cycles), adopted the end-users' likes and interests and were shown to be of educational use by the users (Chapter 5:129) and could be used alongside of traditional methods used in the classroom. Evidence of this was also shown through the practitioners (users) claiming that the concepts in the games echoed the areas they were covering in the classroom and helped some learners' transferable skills into their general educational learning through using their diversity of needs, likes and interests.

The researcher acquired copyright clearance to use Disney and Thomas-the-Tank Engine images in the games being developed. The end-user 4W's practitioner stated that the Thomas-the-Tank Engine game (3rd AR cycle) used the train's face to tell the time and help transferable skills and concepts carried out in the classroom. This concurred with Schneider and Goldstein, (2010) and Karkhaneh et al. (2010) as to the importance of building on this learner's interests. It further gave the practitioner extra educational ideas for using the games in addition to conventional classroom methods.

Semi-face to semi-face third entity

The researcher's observation agrees with other researchers (Miller and Eller-Miller, 2005; VanBergeijk, 2012) that for some learners one-to-one (face-to-face) approaches have not been effective, causing behavioural difficulties and a lack of cooperation (Reported by Stokes, et al. 2001).

Some learners show a marked preference for interacting with computers resulting in the development of their visual processing skills and rote memory. This was demonstrated by end-user 19L using the '**Counting game'** and end-user 1F using beetles (the end-user's interests) in **Polly's Mix and Match game** (4th AR cycle). This concurs with Jones, et al. (2009) and Boucher, (2008) studies as to learners with ASD preferences for using computers. This investigation, therefore, suggests that learners use computers as a 'semi-face'-to-'semi-face' (Chapter 2:8) interactive, non-directive medium, together with users' iterative collaboration and input as a third entity to overcome proximity and interaction difficulties.

This investigation has used an iterative process, which was stated as being of importance by Disability.gov (2011). For these learners to utilise technology appropriately, efficiently and effectively it needs a high level of commitment by the user and others working with them. The study has, therefore, demonstrated this through the maintenance of an iterative use of a collaborative process, which had been monitored, reviewed and modified continuously over many years (Reported by Stokes, 2007, 2008b; Stokes and Whitney, 2008).

Multimedia Therapeutic and Educational Interventions

The investigation used computer games to give learners opportunities and encouragement for communication and language development. Some researchers (Kemp, 2010a, 2010b; Parsons, et al. 2011; Al-Elaimat, 2013) have claimed that the importance of using computers as a learning and therapeutic tool as for some learners with ASD, conventional classroom methods are not an effective therapeutic/educational method.

The 14 batches of games developed (14 AR cycles) resulted in verbal and qualitative evidence from the users from six schools L, R, W, F, N and S that they became aware that the individual games were helping their end-user's transferable skills with difficult areas and concepts being taught in the classroom. An example of these are, telling the time, emotions, shopping.

From the evidence in this investigation (Chapter 5:129), the researcher has regarded that with the diverse modalities of each end-user and preferences of their multimedia elements, the use of multimedia gives practitioners and learners as interactive modality communication tool. This would be through hearing the sound from the speakers, seeing the animated graphics and printed words on the screen plus a tactile medium through touching the screen, switches, mouse or keyboard. This was verified by Charsky, (2010) and de Urturi, (2011) claiming the use of multimedia elements gives an all-round interactive multimedia communication tool.

The process used in this investigation, to develop individual games gave a self-interactive-directed, non-therapist-directed means for learners who have something to say and have a desire to communicate. The second objective was based on the gaps and concerns from the literature review findings (Chapter 2:8; Table 2.11:62) in relation to the end-user's communication, education, curriculum and multimedia therapeutic/ educational interventions and lack of user input. This was addressed in this investigation by successfully ascertaining from practitioners the variance of each learner (end-users) details and needs. This was achieved through the AR cycle of the process through the completion of profiles for the development of individualised computer games with computers being used as a semi-face-to-semi-face entity.

This thereby, concurs with Inclusive Technology (2005) that computer games should match each learner's needs and answers the research question as to… 'How does a CMT/EI process enhance the development of computer games for learners with ASD? (Table 2.13:63; Chapter 2:8; Reported by Stokes, 2003b).

This was achieved through the continuous development of batches (Evaluation AR cycles) of individualised computer games matching each individual's needs, preferences, capabilities, interests and evaluated and tested by practitioners as being of therapeutic/educational benefit/value for their learners with ASD.

6.4 Third objective – Implementation

Methodology

This investigation has discussed the researcher's ontological, epistemological perspectives and viewpoints in order to clarify the process and outcomes through the adoption of McNiff's (2013) action research methodology (Chapter 3:64).

The investigation adopted a cyclical action research design technique for this practice-based investigation, which concurred with Case and Light, (2011) and University of Wollongong, (2011) studies.

Design techniques

The researcher examined many planning, design and evaluation techniques, standards, approaches, guidelines, framework and strategies. This agreed with Disability.Gov, (2011) as to the importance to adopt the appropriate approach for game development, to help alleviate any bias claims and strengthened the reliability and validity of the iterative process (Appendix 1 Table 4B:262, 4.3:98; Fig. 4.3:95 D, E and F; Reported by Stokes, 2008b; Stokes and Whitney, 2008).

Software (Computer games)

The findings from the investigation ascertained that generic off-the-shelf commercial software neither personalised nor took a holistic approach with the development of computer games (Chapter 2:8). This concurs with researchers such as Davis (2007) findings. (Reported by Stokes, 2003a-2003e, 2006a).

Qualitative and quantitative findings showed that a practitioner from School L acknowledged that although there was "some excellent software on the market" (Chapters 4:88 and 5:129) she complained that the staff lacked the time and skills to explore and experiment with costly unknown off-the-shelf software.

The findings revealed that this would be an onerous time-consuming task for users to carry out. Users also commented on the lack of individualised multimedia games and problematical issues relating to software produced for the mass market but labelled as being suitable for learners with special educational needs and were being used in schools.

The users considered generic games as being poorly suited for their learners and that developers do not take into consideration the individual variation and spectrum of needs. These findings corroborate with the literature review findings (Parsons, 2011; Rahman, et al. 2011; Kovalik and Kuo, 2012) that users were not collaborating with manufacturers before games were developed to explain each learner's different needs, preferences, capabilities, levels etc. (Chapter 5:129; Reported by Stokes, 2006b).

The investigation helped to overcome the users' time constraints and workload with a quality control on the games. The quality control was achieved by the development team evaluating and providing feedback before the completion of games, the researcher modified of the games if required before submission to schools and the user's evaluation of the games prior to implementation in the classroom.

The continuous iterative collaborative AR cyclical approach addressed the first objective of this investigation (Reported by Stokes, 2006b). The investigation adopted a Design-For-One approach (Reported by Stokes, 2008b), not just agreeing with Barry and Pitt, (2006) and Dong, et al. (2012) regarding the importance for a User Cantered Design (UCD) approach.

It further addressed areas of concerns and used a more specific individualistic tailored holistic autistic centred Design-For-One approach (Chapters 5:128; Reported by Stokes, 2008a).

Design-For-One approach

At the time of reviewing the literature (Chapter 2:8) there did not seem to be evidence from any studies, research findings, interventions or commercialised off-the-shelf computer games which used an iterative, collaborative, systematic and holistic Design-For-One approach. There further did not be any demonstration of its effectiveness for developing individual therapeutic and/or educational computer games which were considered by practitioners as being of benefit/value for individual end-users with ASD (Reported by Stokes, 2006b, 2008c).

This investigation highlights that each end-user's relationship with the variety and combination of multimedia elements and channels of communication had be extracted from the profiles, through the Design-For-One approach, for the development of individualised interventions. This concurs with Kemp's, (2010a) study for the necessity for developers to take this into consideration. Evidence of this can be seen with end-user 19L's visual, auditory and tactile interaction with the text, sound and animation in the game 'Emotions' (3rd AR cycle) resulting in enhancing his language, communicative and literacy skills.

Text and the tactile modality

There was evidence from the qualitative findings with end-user 1F's practitioner (user) claiming that because of the 'symbols and picture clues to back-up text' together with sound (Chapter 5:129) in the game **'Earn Your Drinks**' (4th AR cycle*)* would be of therapeutic/educational benefit and of value for this end-user.

This concurs with Dempsey and Foreman, (2001); Kemp, (2010a) and Walbam, (2014) that some end-users showed a preference for text, visual and auditory reinforcement and enjoyed the tactile element of physically using computers against using traditional classroom tools (Chapter 2:8).

Sound and the auditory modality

The study highlights sounds can be very distracting for some end-users due to sound sensitivity or the tonality, amplitude and frequency of the human voice (Chapters 2-4:8-88).

This agrees with Checkley, (2010) studies as to some learners difficulties with sound. The findings, from this investigation demonstrated that some end-users responded to consistent artificial vocalisation. This can be seen from the analysis of the quantitative and qualitative findings of the games developed for end-user 17L (3rd AR cycle) with the game using his likes (interests) in baking and cooking stated on his profile. This encouraged, stimulated and motivated his verbal interaction, functional verbal responses, resulting in his imitation of the greeting "Hello" said by a shopkeeper in the game **'Let's Cook'.**

School F's users gave positive comments regarding the sound in the game '**Polly's Mix and Match'** (4th AR cycle) which gave the end-user 1F the 'opportunity to work or say/record what they already know about for example beetles' (Chapter 5:129). For end-user 2F the 'children's voices, which are in **'Mickey's Playtime' game** was nice, along with the jigsaw and multi-syllable words'. End-user 5F's user stated of the '**Egyptian Quest' game** had 'very good voice and music and was excellent for prediction, decision making, listening skills with good visuals and very clear speech'.

The quantitative and qualitative findings from 19L's game (2nd AR cycle), disclosed that this learner produced functional verbal language in context plus communicative vocal sounds. The learner, however, gave a negative response to dogs barking in the game owing to an unknown fear of dogs. This was rectified during the evolutionary process.

Barking dogs or other disruptive sounds may also be incorporated in commercial software as the manufacturers do not take into consideration individual needs and dislikes/fears. Whereas, this process was able to be amended through the iterative approach which generic off-the-shelf computer games are unable to be aware of in order to modify the development of their non-individualised computer games.

Graphics and animation and the visual modality

The findings demonstrated that visual, auditory and/or tactile learners, (owing to their language difficulties with the written and printed word), were more stimulated and motivated by exploiting their visual modality. This was achieved using visual images, graphics and symbols plus visually effective communication (e.g. animation) (Chapter 5:129). This agrees with Kameneva, (1999), Macaskill, (2005), Kemp, (2010a) and Berk, (2011) studies as to the importance of using appropriate graphics and animation in computer games. The qualitative results (Chapter 5:129) demonstrated that the users considered how the graphics aided organising, sequencing and understanding tasks, reading activities, language skills including imitation and communication. This demonstrated how the literacy experience in the classroom, using a thematic approach, gave educational advancements as stated by Berk, (2011). User's from School F's evaluation of the storyboards on the 4th batch of games (4th AR cycle) (Chapter 5:129) resulted in positive comments regarding the graphics, animation and visual content had 'very good pictures', '*5* levels', 'pupil will love it great', 'electric circuit', 'nice clever graphics with the spelling game', 'fun', 'with great rewards'.

Visual (Graphics and Animation) and auditory (Sound)

This study demonstrated the personalisation of graphics and sounds helped to stimulate and motivate the learners and give further language, communication and educational opportunities as indicated in Leontidis et al. (2011) studies (Reported by Stokes, 2003a).

The results (Chapter 5:129) regarding incorporating graphics and sound appropriately, there was evidence that these features were especially beneficial and effective for some learners. The qualitative findings from Stage II of the prototype of the 3rd and 4th AR cycles, revealed that School R's ICT coordinator and head practitioner's evaluation saw the process as an exciting initiative and gave positive comments regarding the high standard of the graphics, sound etc. in the games.

The results from School F's users' evaluations of the storyboards and games (4th and 5th AR cycles) from this iterative practice-based process, confirmed that personalisation gave encouraging positive feedback and reinforcement in-line with each end-user's appropriate multimedia needs thereby catching the learner's attention and helping them to focus (Reported by Stokes, 2008c).

The researcher was also granted copyright clearance for the use of the Makaton sign language images and the music and lyrics of the band Coldplay. These were used in the appropriate games, based on the end-user's preferences, likes and interests, together with the inclusion of their first name as stated on the profiles. The games were increased to four activities e.g. literacy skills, numeracy skills, social skills and communication skills. Each activity having four levels, with the first level being the easiest. The users from Schools N and S using the games from 2005-2014 (6th-14th AR cycles) continually claimed the therapeutic and educational benefits/value of the games for their learners.

This practice-based action research investigation was, therefore, successful in using an autistic-centred holistic Design-For-One approach by effectively developing personalised customised individualised therapeutic/educational computer games for learners with ASD (Reported by Stokes, 2003a, 2003c, 2008c, Stokes and Whitney, 2008). This confirms Yates and Couteur's (2013: 5) claims the importance of not just taking individual's 'strengths, impairments, skills and needs' but also a more holistic approach.

This demonstrates how the third objective addressed the gaps and concerns (Tables 2.11:60) from the literature review (Chapter 2:8) in relation to methodology, design techniques, modalities and multimedia element preferences. This, thereby, answered the research questions demonstrating how the CMT/EI process enhanced the development of individualised computer games for learners with ASD and the barriers and opportunities, which emerged from the process. (Table 2.13:63).

6.5 Fourth objective - The process continually carried out with large groups of participants.

The researcher created and developed a university multimedia module to enable students to use their research and computing skills to develop multimedia games as their assignment. This practice-base action research methodology enabled many cohorts of students to carry out this assignment over ten years. Society was brought into academia by giving each student a completed real learner profile to develop beneficial computer games, for both users and end-users. The researcher received continuous positive verbal and written feedback from the students regarding the assignment (Appendix 2:68). Constructive feedback and positive comments from schools in relation to the games were disseminated to students. There was, however, no literature review (Chapter 2:8) evidence of this approach, module and/or assignment, which had been used before.

It can be seen from this iterative investigation how the fourth objective had been met and the research question, as to 'What are the barriers and opportunities of such a process?' (Table 2.13:63) was answered. This had been achieved by over 2,000 university students together with 68 tutors and the researcher (the development team), over a period of 10 years. This was through an assignment which enabled the development of individualised computer games for 464 real end-users with ASD, through an iterative (14 cycles) AR cyclical Design-for-One process. This resulted in the evaluation by 49 users, from nine educational establishments as to the therapeutic/ educational benefits of the games over an extended period of time.

6.6 The Computerised Multimedia Therapeutic/Educational Intervention (CMT/EI) process

On reflection, this investigation has answered the research question **'**How the Computerised Multimedia Therapeutic/Educational Intervention (CMT/EI) process enhanced the development of computer games for learners with ASD?', through the iterative collaborative involvement of the practitioners. Practitioners chose end-users and completed and modified profiles. They were given the opportunity to give feedback and suggestions for improvement, which was disseminated by the researcher to the development team.

Practitioners chose the most appropriate games to implement in the classrooms. They evaluated the therapeutic/educational effectiveness of the storyboards and games. They included new end-users through the iteration. The iterative process enabled them to receive continuous customised games, made to their specifications as stated by them on profiles. The investigation shows that the on-going process resulted in the development of appropriate therapeutic/educational games evaluated by the practitioners over a number of years, (particular for Schools, L, F, N and S).

The action research (AR) methodology achieved an iterative collaborative partnership and good mutual rapport with cohorts of university students and the practitioners from schools. It changed the practitioners from schools' ethos to the adoption of a more whole school approach (Chapter 5:129). Furthermore, the aims of the study has been met by demonstrating the effectiveness of the therapeutic (language and/or communication) and educational benefits/value of the individualised tailored games. The iterative reflection, updating and modification/amendments to the iterative process (Stages I and II) led to improvements, expansion, benefits and gratification by all the parties involved and to the dissemination of good practice through publications (Reported by Stokes, 2003c, 2003d, 2006b and 2008c).

6.7 Fifth objective – The evaluation of games before implementation

The fifth objective was to enable the multimedia software development team (university students and academics) and the practitioners evaluate the games before implementation in the classroom.

This was achieved using this practice-based action research approach through the:

- continuous software development team's evaluation of games (for quality control) with the completion of assignment marking criteria forms against the profiles. This resulted in formative verbal and written feedback enabling students to amend the games prior to submission for grading.

- The researcher further evaluated all the final products (computer games) amending them appropriately (for quality control) prior to submission to schools.

- The users similarly evaluated the games using an initial evaluation sheet (for quality control). This resulted in their choice of games, which they considered to be of therapeutic/educational use to implement in the classroom. They further modified profiles, issued new end-user' profiles and gave suggestions and constructive feedback which the researcher disseminated to the students.

Studies were not demonstrating that users (practitioners) were having an input in the design and evaluation of therapeutic/educational computer games.

The fifth objective had, therefore, been met with the multimedia software development team (university students and academics), the researcher and practitioners all evaluating each of the games (for quality control) before implementation in the classroom.

6.8 University students undertaking a real assignment

The investigation set out to ascertain as to what will be demonstrated by the university students undertaking a real assignment for the autistic communities.

The literature research had not determined any evidence of university students developing individual games, using profiles of real learners in the autistic community as a real assignment on a continuous basis as used by this investigation.

This study has demonstrated (Chapters 4:88 and 5:129) that by being part of a software development team, the students gained theoretical knowledge and learnt academic and practical multimedia skills whilst becoming aware of autism and other disabilities. Accordingly, the students took great pride in producing products, which were beneficial to the disabled community (Appendix 2:268).

Whereas, the researcher's professional knowledge teaching in academia have indicated that previous assignments used hypothetical scenarios, non-real-world situations, were non-collaborative with society and did not benefit others but were merely to achieve a grade and pass coursework. The students' feedback (Appendix2:268) revealed that their active role in this investigation gave them a far more worthwhile assignment in which they related their studies to real-life situations in today's society rather than their other theoretical assignments within the 'academic-world' of the university (Reported by Stokes, 2007, 2008d, 2014a and 2014b).

The researcher agrees with Foot and Sanford, (2004:256) that students gained an understanding of research activity and 'a better appreciation of the process' when involved in the research. Their intensified involvement with their area of study led some students to become personally involved with their assignment, referring to their anonymous profiles as 'my child' (Reported by Stokes, 2007 and 2008d).

Cohorts of students gave written positive iterative feedback indicating that they found the assignment 'very rewarding' (Appendix2:268). This authentic assignment had achieved really useful, effective, efficient, and enjoyable results for the researcher, the academics, the students, the users and the end-users (Reported by Stokes, 2007 and 2008d).

Students acquired a greater self-satisfaction and sense of achievement and were able to relate what they learnt in the academic environment whilst contributing to society by developing a product for the good of humankind, as well as their own personal achievement (Appendix 2:268).

They claimed they gained a far more positive, useful and rewarding experience than just receiving a grade (Reported by Stokes, 2007 and 2008d). Some students became Student Representatives and Student Learning Assistants (SLA) (Appendix 2:268).

Tutors identify students who have passed the module to return to the classroom, whilst they are studying and help students who were having difficulties and to pass on their knowledge and experience. This was carried out as a pilot study by the researcher in 2008 and which was implemented by the Vice Chancellor throughout the university over the years, for all the university schools, in London and overseas campuses and is still in operation.

This module/assignment, originator by the researcher, helped students develop lifelong learning skills and increase their employability prospects e.g. one student demonstrated the game she had developed as a first year (undertaking the researcher's module) at interviews with Microsoft and Hewlett Packard UK. The graduate was offered both jobs and is still employed at Microsoft (Reported by Stokes, 2006b). Consequently, the transition for students from university life to society was augmented by their experience, with some gaining voluntary and full employment within the disabled community whilst others continued to their undergraduate and postgraduate studies by researching in the area of autism and other disabilities (Reported by Stokes, 2007, 2008d).

6.9 Further collaborative ventures

The investigation set out to ascertain as to how the CMT/EI process was of continuous use to practitioners, affected others and led to collaborating ventures.

The Cambridge University Autism Research Centre's team became interested in this investigation (Reported by Stokes, 2006b) and gave rise to the formation of a Joint Autism Research Group (JARG) with a cooperative project 'using electrophysiological measures of brain responses to develop individualised educational multimedia games for end-users with autism. This project was to establish whether there is evidence of brain activity/stimulation in relation to each element of multimedia (text, sound, graphics, animation and video) when personalised, individualised, tailored games are being used by 12 verbal end-users as compared with generic software. A proposal has been compiled ready to submit for funding.

This investigation has also led to a research proposal for an FE or HE Software Development Company, consisting of academics, undergraduates and postgraduates students collaborating with therapists and educationalists (users) and disabled learners (end-users) for the development of games as per this study.

The researcher has approached a university with a proposal of a project for a masters or PhD student. This project would investigate if individualised computer gaming .apps were more therapeutically/educationally beneficial for real end-users in comparison with a control group using the same yet non-individualised computer games. The researcher has proposed the CMT/EI process used for this investigation could be adopted for this study.

6.10 The Conclusion

This thesis provides a comprehensive literature review from refereed publications and past studies relating to autism, speech, language and communication, education and multimedia interventions.

The areas examined and discussed helped to establish the background to the study and to address the gaps and concerns in the literature review, which were not being addressed by researchers, developers and studies.

Critiquing this investigation highlights how these difficulties were addressed and how recent research, since this investigation was carried out, were beginning to address some of the issues and showing an improvement in the development computer games, using new technology, for learners with ASD. The areas the study highlighted and achieved were:

- **large studies with the involvement of large groups of participants**
  - this was achieved through on-going collaboration (input, evaluation, implementation, testing, monitoring of storyboard/games).

- The participants were 49 practitioners (users), from seven schools and two educational establishments, over 2,000 students and 50 tutors, participated for the development of individualised computer games for 464 learners (end-users) with ASD. This investigation would have benefitted from using multidisciplinary teams. The limited input from Speech and Language Therapists (SALTs) resulted in the teachers contributing and imparting their therapeutic knowledge into the investigation. Using large groups of participants, therefore, demonstrated the on-going maintenance of the project.

Although Vlachou and Drigas, (2017:1) recent study were not demonstrating the on-going maintenance of the effective use of mobile technology .apps, meeting large groups of learners with ASD's needs. Their study demonstrated the effectiveness of mobile technology as an assessment and treatment intervention to capture and interpret data concerning some learner's learning and behaviour. They further highlighted the importance of the collaboration and involvement of all participants, educators, carers, learners and families 'in the design and implementation of the appropriate .apps, which would match learners with ASD's needs and provide them with a better quality of life'.

- Software developers and researchers need to be aware that studies are still being carried out on relatively small sample sizes of similar learners. This was rectified with the development of individualised games for 464 end-users from nine establishments.

Barajas, et al's. (2017) carried out a recent empirical study at the Distributed and Collaborative Virtual Environment Research laboratory (DISCOVER Lab) University of Ottawa, Canada. Their research was the use of a Tangible User Interface (TUI) with physical use of Lego-like building blocks and a 3D Graphical User Interface (GUI) to represent a virtual view of the board and the blocks. This was a collaborative play therapy exercise tool to aid children on the Autism Spectrum Disorder's (ASD) social and cognitive skills and decrease their solitary play.

The participants were nine boys diagnosed with ASD and aged between 6 and 15 years. The tests were carried out one hour each day on two consecutive days. Five children were tested on the first day and four children on the second day. Their results demonstrated that children's performance were significantly better with the computer game with the visuals and interactive computer feedback. This enabled the learners to complete the game levels faster. Nevertheless, these researchers claimed in their conclusion, that it was their intention to use a bigger sample size to see if their results stand and to enable them to generalise their results in future studies.

- **the development of large amount of individualised games developed**
  - this investigation developed over 2,000 individualised computer games for individual learners with ASD, whereas other studies had developed one non-individualised computer product and tested it on a few participants.

Not only did this investigation take into consideration the diversity of each learners, needs, capabilities and preferences, the study also personalised the individualised therapeutic/educational games by using learners first names and their interests, which demonstrated to be effective.

FitzGerald et al's. (2017:1) recent study claimed that although research over the years have demonstrated positive effects of personalisation …it is often difficult to know how to implement it effectively within educational technology… and have resulted in proposing a framework with case studies and design guidelines.

- **individual computer games specifically developed for large group of learners with ASD**
  - This investigation used 464 learners with ASD from numerous schools and educational establishments. Nevertheless, recent studies are still demonstrating the effectiveness of products developed and tested on individuals or a few participants in one school.

Alzrayer, et al's recent (2017) study on systematic instructions for multistep requesting skills for learners with ASD using IPad. Although the results of study demonstrated the effectiveness, it demonstrates that studies were still only being carried out was with a small group of four participants between the ages of 8-10 in one environment.

- **products only tested out once**
  - Some studies tested products out once (for a short period of time) and not retested the product with the same end-users or others in other environments as this investigation has demonstrated.

Luisa Lorusso et al (2017) recently research which evaluated the learnability, usability, user satisfaction and quality of interaction of 14 pre-school children with language impairments playing with objects in an .app on a tablets (smart technology) during a 45 minute speech therapy session.

- **collaboration with practitioners and the development team**
  - the researcher collaborated with large groups of (49) practitioners on a continuous basis.
  - She also had on-going teaching and collaboration with a development team of cohorts of students (over 2,000 students) and 49 tutors for the development of individualised computer games.
  - Studies were not demonstrating academics working with collaboration with practitioners as co-software designers, co-software developers, co-software evaluators on individualised computer games as carried out in this investigation.

This investigation, therefore, suggested that the CMT/EI process could be used by developers and researchers for the development of individualised .apps for tablets through the collaboration with practitioners. This is reinforced in King, et al's. (2017) recent study, carried out in Southern Illinois University Edwardsville, USA, which emphasised gaps between current research and 'real world' practice.

They suggested the importance of a crucial component for further research is to gain the perspectives of the practitioners. In Whalen (2017) recent dissertation into technological advances in play for learners with ASD the researcher further advocates the importance of game designers needing to collaborate with practitioners for the development of therapeutic games.

- **studies carried out over an extended period of time with many participants**

  - this investigation suggests that interventions need to be repeatedly tested over a period of time in different environments and with many participants on an iterative basis. This is due to learners with ASD's intolerance for change of structure, their therapeutic, educational, behavioural impairments and their transition and inconsistency difficulties. This investigation carried out the process over 10 years.

Although some studies are now using larger groups of participants e.g. 74 low-functioning learner's with ASD using customised ICT tool over 25 sessions to recognise objects, improve attention, concentration, visual tracking, categorisation and communication skills (Vélez-Coto, et al. (2017).

It would have been interesting if Vélez-Coto, et al's study had been carried out in different environments over an extended period of time.

- **using software in more than one school/educational establishment**

  - some studies were only carried out using one school, over a short period of time, as a one-off and not on an iterative basis with learners in further educational establishments. This investigation carried out an initial application procedure with one school (which was piloted) and then went on to pilot a prototype procedure with a further three schools and then as a prototype with a further five educational establishments.

- Stage I of the CMT/EI was the design and development process, which was carried out with all nine educational establishments. Stage II (the experimental part) of the CMT/EI process, the evaluation, testing, recording and monitoring by the practitioners was carried out with four schools. This was carried out on an iterative basis over many years.

Although Holt and Yuill (2017:1) recent study had only been implemented in one environment it made an interesting comparison of the use of single and dual-wifi-linked tablets for awareness, imitation and communicative behaviour. This was achieved by 8 male learners with ASD aged 5-12 collaboratively playing on a picture sequencing game with an adult of another learner with ASD. The results showed active other-awareness, behaviour absent, more communicative behaviour claiming the effectiveness of the software for their social-cognitive development. It would be interesting to establish if this could be achieved in other environments and further establish its therapeutic and educational benefits/value using this .apps if designed using the CMT/EI process as used in this investigation.

- **a university module and assignment designed for the development of individualised computer games for learners with ASD**

  - As a cyclical practice-based evaluative action research, the researcher originated and successful taught on a module in a computing science degree and developed an assignment which taught cohorts of students to research, design, developed and evaluated (other students) computer games developed for learners with ASD over 10 years.
  - timescales were mismatched but were satisfactorily addressed, as students worked over 24 weeks whilst schools worked in terms and half-terms from September-July.
  - At the time of this investigation, there was no evidence that this had being achieved in academia. The investigation has demonstrated how this assignment increased student's motivation and raised their standard of work.

- **Autism awareness**
  - through a cyclical practice-based evaluation action research, the researcher ensured that cohorts of the development team (consisting of university students and academics), over 10 years, who had little or no previous awareness of autism spectrum disorder had a thorough understanding of autism.
  - The researcher taught and supervised students research and multimedia skills to develop individual multimedia therapeutic/ educational games for real end-users with ASD in society, thereby bringing society into academia. At the time this research was being carried out there was no evidence of this being achieved by other institutions.

- **the development and use of profiles**
  - the researcher developed and continuously modified a template profile. The completed profiles (by practitioners) were successfully used as a baseline to develop individualised computer games for learners with ASD.
  - The computer games developed needed to match the end-users' diverse needs.
  - Many shortcomings such as the limited information on the profiles, time constraints, workload, empathy, motivation and challenges had been overcome.

- **ascertaining the diversity of learners with ASD needs, preferences, likes and interests**
  - the diversity of each learner (end-user) with ASD's medical, autistic, therapeutic and educational needs, preferences, capabilities, likes and interests had been taken into consideration from the completion of profiles. This was used as a baseline for the development of computer games.

- Studies were not demonstrating what the variance of each learner's therapeutic/educational skills were and were further not matching them to products developed for individual learners with ASD.

Barajas, et al. (2017) carried out a recent empirical study showing the effectiveness of using building blocks in computer software used by learners with ASD. They choose to use building blocks as they claimed that it had been proven to be of social benefits and the popularity of the toy. They had not indicated if the participants had been particularly chosen because of their interests. It would be interesting to establish from a profile the learner's interest and to ascertain the therapeutic/education benefits of this software.

Hosseini and Foutohi-Ghazvini's, (2017) recent study carried out at University of Qom, Qom, Iran had not demonstrated they had taken into consideration the diversity of each of the end-users' diversity of needs, preferences etc. They had highlighted in their study the effectiveness that Autism therapies ("PECS") and the incorporation and implementation of virtual 3D objects in digital mobile augmented computerised games. They claimed this demonstrated an influential bridge for some learners with ASD and the real environment around them. The researcher suggests that future developers and researcher could adopt and adapt the CMT/EI process used in this investigation, for individualised 3D therapeutic/educational game development, for tablets and mobile technology, to support users and their end-users with ASD.

- **the acquirement of copyright images and music**
  - the researcher acquired copyright clearance from Disney, Thomas-the-Tank Engine, the band Coldplay, Makaton Sign Language and CBeebies, as her knowledge and understanding of the learners with the ASD have specific interests. If indicated by the practitioners on the profile as being of interest to the learners these were included in the individualised software and were shown to be of therapeutic/educational benefit/value for the learners.

At the time of this investigation, however, there did not seem to be any studies that included the end-user's interests, by acquiring copyright images and music and incorporating them into individualised computer games demonstrating to be of benefit/value for learners with ASD.

- **a cyclical Evaluation Action Research (AR) collaborative, individualised, holistic "Design-For-One" approach**
  - this practice-based investigation adopted and adapted a cyclical evaluation AR collaborative individualised holistic Design-For-One approach. This was achieved through the development of 14th batches of individualised computer games, through 14 AR cycles of a CMT/EI process. This was not demonstrated in recent studies.

- **practitioner's evaluation and implementation of computer software**
  - this investigation resulted in the evaluation of more than 200 computer games by practitioners from seven schools.
  - Four schools further implemented 139 individualised computer games in classrooms and demonstrated evidence as to the therapeutic/educational benefit/value of the games.

Eliçin and Kaya (2017) recently carried out research on 67 experimental published research studies (between 1995 and 2015) in relation to learners with ASD using high-tech devices. Their findings were indicating that computer devices were demonstrating to be effective for academic, communication and social-emotional skills.

Nevertheless, they claimed that there were only a limited number of these studies and that studies were not stipulating whether the learners had a diagnosis on the ASD. They suggested that more studies should be reporting on the analysis of the efficiency of the utilisation of the technology and an increase in studies demonstrating the use of computers for teaching academic skills.

The overall evaluation of the positive results confirms the goal, that computerised multimedia intervention (the CMT/EI process) has not only been evaluated by practitioners as being of use but the customised computer games have also demonstrated to be of therapeutic benefit/value for their learners on the autism spectrum).

The study further demonstrated that the personalised products were also of educational benefit/value to users and end-users as the individualised games re-enforced already learnt educational issues and transferable skills.

The positive benefits, advantages and results of the project have led to influencing others and future collaborative ventures. This would contribute to a better understanding of the efficacy of this intervention.

This empirical practice-based evaluation and action research inquiry has been demonstrated to provide a valuable, original and academic contribution to knowledge in the fields of computing, language and communication therapy and education through the researcher's group skills, managerial ability, sensitivity of all the participants, formative and summative feedback to and from the practitioners and students. This resulted in answering the research questions through the successful use of the objectives, addressing the gaps and concerns. This thereby met the aims of the investigation, as to the therapeutic (language and/or communication) and educational (literature and numeracy)' benefit/value of individualised tailored computer games for learners with Autism Spectrum Disorder (ASD).

6.11 Further Work

The researcher suggests about the further future progression of this investigation and suggests guidelines to follow for the replication the process (Chapter 5:129). The researcher agrees with Wing, (1988); Boucher, (2008); Kemp, (2010a) and Schopler and Mesibov's, (2013) that future interventions need to assess the underlying factors affecting learning of individuals with ASD before the development of products.

It is suggested that future researchers adopting this process should incorporate the categories, duration, use and effectiveness of strategies, targets and interventions from the Individual Education Plan (IEP) and the multidisciplinary team. These, together with each learners' first name could be incorporated into the profiles and used as a baseline for the development of an even more appealing, stimulating, motivating iterative personalised and customised intervention for each learner.

Future investigations should look to adopting interventions such as Makaton signs and TEACCH symbols if appropriate for specific end-users. This would all enhance the use and effectiveness of the process for further research.

The investigation would like to draw future researchers and software developer's attention to the difficulties caused by using educational establishments and how this was overcome in this study. Areas such as the users' lack of interest and their time constraints would need to be taken into consideration (Reported by Stokes, 2006a).

Although at the time of carrying out this investigation there was a lack of speech and language therapists (SALTs), the investigation proposes that future studies would benefit from the collaboration and involvement of not only SALTs but the multidisciplinary team of professionals involved with each end-user (Li, et al. 2013). This had been proposed by other researchers (Wing, 1988; Schopler and Mesibov, 2013; Parsons et al. 2015). This would help to give a much fuller holistic knowledge of the diversity of each learner's needs (Reported by Stokes et al. 2001 and Stokes, 2008a).

The researcher suggests that computer games developed by using this process should be used over a period of time alongside and complimenting conventional therapeutic and educational interventions commercialised and off-the-shelf educational software. This should be monitored to demonstrate further therapeutic/educational use.

It would be interesting to see if further research using the CMT/EI process within other areas of the school curriculum would give end-users further stimulating, motivating, individualised educational opportunities (Reported by Stokes, 2006b).

It is suggested that future researcher's adopting this process should have the categories from the IEP incorporated into the profile, thereby ascertaining and monitoring the interventions previously tried against particular areas, the duration, use and effectiveness in relation to each learner's needs (Reported by Stokes, 2014a, 2014b).

This investigation also suggests that future studies should adopt the holistic "Design-For-One" approach, as used in this investigation, for developing computer games for users working with learners with difficulties and disabilities not just for learners with autism spectrum disorder (Reported by Stokes, 2006a and 2006b).

A quantitative approach could be used to make comparisons with age, ethnic origin, specific needs, capabilities, preferences etc. Future mobile technology, robotics and sensory and accessibility interventions could adopt the CMT/EI process and "Design-For-One" approach for learners with ASD.

I, therefore, put forward the adoption of this project, which has demonstrated examples of good practice through its continuous use and a sound basis from which to establish a computerised therapeutic/educational model, which is of use to a multidisciplinary team of practitioners (users) and learners on the autism spectrum (end-users) and for learners with other disabilities. This is more than the thesis' original notion of a computerised multimedia intervention being of use to practitioners.

This investigation, therefore, will make a valuable, original academic contribution to the Computer Science, Special Educational Needs, Language and Communication (Therapeutic) and Education fields.

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Appendix

Appendix 1 – Tables

Table 4A. Complexity of the project and layers of product activity – Role of the Academic (Researcher)

Role	Activities
Module Leader/ Researcher	Overseeing and facilitating the module, the tutors, the students The creation of the module and assignment Evaluation and modification of ALL games developed before submission to schools
Assignment	Individually produced well researched, well cited and appropriately referenced reflective evaluation word-processed report based on the profile and research findings. Storyboard A Director movie (game) with use of peer evaluation of other student's games
Lecturer/ Researcher	Helps students examine the perception, development and impact of multimedia technology. Introduces students to the variety of media elements text. Sound, graphics, animation, video, hardware and software components and the necessity for interactivity in multimedia. To help and encourage students to develop their imaginative, creative and design skills using various multimedia applications and delivery modes. Help students become knowledgeable and reflective about the current and forecasted multimedia technologies and appreciate of the effects multimedia is having on society and in our lives by developing games for real learners with ASD. Lecturer covered in lectures:.. -The introduction to the module and multimedia -The evolution of multimedia -The strength of the word- text and hypertext/ HCI/User Centred Design Approach/ Understanding the autistic end-user and the profiles/visual perception -Design principles and techniques/Ergonomics -Digital Audio and Musical Instrument Digital Interface (MIDI) Technology -The fundamentals of ergonomics and Digital photography, images and the power of 2D and 3D of animation and graphics -An overview of Multimedia Design, use of Authoring Tools, Application Development and the Development Lifecycle/Ethics/multimedia projects, planning, designing and management, -An introduction to video, video conferencing and virtual reality -An understanding of HTML, Python programming and Lingo script/Multimedia software and storage devices and CD/DVD-ROM technology -Marketing Multimedia, The Development Team and Multimedia Ethics -The internet/the web/The future and convergence of multimedia technology/mobile technology/robotics -Demonstration by examples games and previous games developed

Role	Activities
Lab tutor/Project manager/ designer/ Lecturer/Researcher	Teaching – based on profile - Research and study skills. - Imaging editing/graphics (Photoshop software –using their own images)- - Digital Audio Technology (Cool Edit/Cubasis VST software recording their own voices and music) - Animation/Authoring software (Director software). - Demonstrating by examples - Demonstrating the creation on storyboards - Matching profiles to games - Students evaluating each other work using evaluation criteria created by researcher. -Tutors evaluation of students work using evaluation criteria created by researcher
Learning Outcomes	The aim of this module is for students to gain knowledge, cognitive, subject specific and transferable skills (as stated in the module handbook listed in the learning outcomes.

Table 4B – The complexity of working with different schools

Schools	Researcher	Interventions in schools The different ways users engaged with the project	End-users participation
All schools	Contacted (except School S-see below) Originated and submitted permission letters Template profiles originated and submitted	User/users discussed with researcher Users chose end-users and completed profiles	N/A
School L (Jan 2003-June 2008 – 9 AR cycles-9 batches of games	Submitted storyboards+ evaluation sheet Submitted games + evaluation sheet Submitted diary templates, questionnaires, Carried out telephone and semi-structured interviews Non-participant observations	Returned completed evaluation sheet on storyboards Returned completed evaluation sheets on games Recorded and complete diary entries and Completed questionnaires Verified interviews Worked with end-users on games whilst being observed.	N/A Played with games whilst users monitored recorded on diary sheets Played with games with users whilst being observed.
School C – Sept 2003-Jan 2004 (1 AR cycle)	Submitted games + evaluation sheet	Written evaluation of games	N/S
School R Sept 2003-Jan 2005 (3 AR cycles)	Submitted print outs+ evaluation sheet Submitted games + evaluation sheet	Written evaluation of print outs Returned completed evaluation of games	N/S
School W Sept 2003-Jan 2005 (3 AR cycles)	Submitted games + evaluation sheet	Returned completed evaluation of games	N/S
School F Sept 2004-Jan 2006 (3 AR cycles)	Submitted storyboards+ evaluation sheet Submitted games + evaluation sheet	Returned completed evaluation of storyboards Returned completed evaluation of games	End-users played with games
Computer Club (CC) 2006 (1 AR cycle)	Submitted games + evaluation sheet	Did not evaluate games	N/S

Schools	**Researcher**	**Interventions in schools The different ways users engaged with the project**	**End-users participation**
Home/School (H/S) 2006 (1 AR cycle)	Submitted games + evaluation sheet	Verbal and written evaluation games	N/S
School N 2007-2010 (6 cycles)	Submitted storyboards+ evaluation sheet Submitted games + evaluation sheet	Gave verbal and written evaluation of storyboards Gave verbal and written evaluation of games	Stated end-users were playing with the games
School S 2010-2013 (3 AR cycles)	School contacted Researcher Submitted storyboards+ evaluation sheet Submitted games + evaluation sheet	Gave verbal and written evaluation of storyboards Gave verbal and written evaluation of games	Stated end-users were playing with the games

Table 4C The research and product activity

Research	The university teacher	The participants	Potentially the wider field of practice
The knowledge being created through the project	Give students real end-users resulted in good feedback (Appendix 2) from the students Voluntary and paid job opportunities Motivated them to continue with projects, dissertations, Masters and PhD studies in disabilities Positive feedback given directly to them from the Deputy head of school	Enabled the practitioners to have an input as co-designer Enabled practitioners to evaluated storyboards, print outs, games as to their therapeutic/ educational effectiveness.	Software developers and researchers: taking into consideration a holistic Design-For-Approach when developing computer games for learners with ASD. Taking into consideration the diversity of their therapeutic/educational needs, preferences, capabilities, likes, dislikes and interests Users (Practitioners) evaluation of computer games therapeutic/ educational benefits prior and when implemented in the classrooms. Piloting and testing with large groups of participants in a variety of educational establishments over an extended period of time.
The ways the project has contributed to changing perspectives or practice	Giving university students an assignment, which would help others in society - a real problem.	School policy changing to using computer games for therapeutic as well as educational purpose Changing to a whole school approach	The consideration of the Design-For-One approach for these learners in the future.

Table 4D Development of Games

Educational establishments/ No. of users participated	**No of end-users whom had games developed. No of students and games developed.** 150 students and games – SEM 1 * 50 students and games – SEM 2 **	**No of games Evaluated (E) /implemented (I)**	**AR cycles/ batch of games developed**
School L A 52-week residential school. (Initial Application) 6 teachers	Jan-June 2003 ** 27 end-users – (narrowed down to… Sept 2003- Jan 2004 * 6 end-users (4 verbal and 2 non-verbal end-users)) repeated… Jan 2004-June 2004 ** increased by 12 and Sept 2004-Jan 2005 * = 45 end users (39 male and 5 female) Ages ranging from 5-18. Jan-June 2005 ** 17 end users repeated Sept 2005-Jan 2006* Repeated Jan 2006-=June 2006** Repeated Sept 2006- Jan 2007* Repeated Sept 2007- June 2008* = 136 end-users	0 2(E) (6 end-users) 12(I) (6 end-users)	1 AR cycle/1st batch 2nd AR cycle/ 2nd batch 3rd AR cycle//3rd batch 4th AR cycle/4th batch 5th AR cycle/5th batch 6th AR cycle/6th batch 7th AR cycle/7th batch 8th AR cycle/8th batch 9th AR cycles/9th batch

Educational establishments/ No. of users participated	**No of end-users whom had games developed. No of students and games developed.** 150 students and games – SEM 1 * 50 students and games – SEM 2 **	**No of games Evaluated (E) /implemented (I)**	**AR cycles/ batch of games developed**
School C - a primary school with 10 places in an Autism Base (Pilot Prototype) 2 SALTs	Sept 2003- Jan 2004 * 13 verbal end-users (10 male and 3 female) Aged 4-11 with moderate learning difficulties=13	13 (E)	2nd AR cycle/2nd batch
School R - a primary school for 49 end-users Pilot Prototype) Deputy head teacher 1x Assistant Psychologist (AP) and 1 x ICT Co-Ordinator	Sept 2003- Jan 2004 * 19 end-users (10 verbal and 9 non- verbal) Aged 3-11 with severe to moderate learning difficulties and ASD. +5 = Increased to 24 end-users (22 males and 2 females) Jan 2004-June 2004 ** Sept 2004-Jan 2005 * 24 end-users =68	24 (E)	2nd AR cycle/2nd batch 3rd AR cycle/3rd batch 4th AR cycle/4th batch
School W - a primary school catering for 100 end-users and a further 10 in the Autism Base (Pilot Prototype) 7 teachers, 1x SALT + a professional, 3 x Teaching assistant	Sept 2003- Jan 2004 * Jan 2004-June 2004 ** Sept 2004-Jan 2005 * 7 male verbal end-users. Aged 5 -11 with moderate learning difficulties end-users. = 21 end-users	28 (E/I)	2nd AR cycle/2nd batch 3rd AR cycle/3rd batch 4th AR cycle/4th batch
School F is regarded as a community mainstream primary school Prototype) 1 Teacher	Sept 2004-Jan 2005 * 5 male end-users aged 3-11 (AS and Asperger's) end-users repeated Jan-June 2005** Sept 2005-Jan 2006* = 15 end-users	20 (E)	4th AR cycle/4th batch 5th AR cycle/5th batch 6th AR cycle/6th batch
Computer club (CC) in London (Prototype) 1 Teacher	Jan-June 2005 6 end-users. (see above * = 6 end-users	0	5th AR cycle/5th batch

Educational establishments/ No. of users participated	**No of end-users whom had games developed. No of students and games developed.** 150 students and games – SEM 1 * 50 students and games – SEM 2 **	**No of games Evaluated (E) /implemented (I)**	**AR cycles/ batch of games developed**
Home and School (H/S) 1 x Parent + 1 x Teaching Assistant + 1 SALT	Jan-June 2006 1 end-user (see above ** =1 end-users	1(E)	5th AR cycle/5th batch
School N is a school for verbal end-users taught in groups of 7 in 4 classes) 9 x Teaching staff + 1 x Deputy Head/Autism/ICT Co-Ordinator	Sept -Jan 2006 9 (male) end-users in 2006, which increased over the years (2007-2010) to 15 (male) end-users. Aged 3-11 with Moderate Learning and communication difficulties, and some with additional and complex needs such as Autism and sensory or physical needs, using a total communication approach. =24 x 5 = end-users = 120 (see above **) = 129 end-users	69 (E and I)	6th AR cycle/6th batch 7th AR cycle/7th batch 8th AR cycle/8th batch 9th AR cycle/ 9th batch 10th AR cycle/10th batch 11th AR cycle/11th batch
School S is a primary school for 75 end-users The Early Years - Autism Provision - 2 infant classes - end-users and learning difficulties. 10 x Teaching Staff	Sept 2010-2013 9 verbal end-users (male) aged 4-11 with Moderate Learning Difficulties (MLD) age range 4 to 11 years were used in 2010 and 2011-2013x2=66 end-users to 33 end-users (29 male and 4 female) = 75 end-users	108 (E and I)	12th AR cycle/12th batch 13th AR cycle/13th batch 14th AR cycle/14th batch
9 Educational establishment = 49 practitioners + 1 x parent (users)	464 end-users 2,050 games developed 2,050 students	197 games evaluated 139 games implemented 40 games tested	14 AR cycles/ 14 bathes of games

Appendix 2

Student Feedback

Dear Elizabeth,
Studying your multimedia module and the main assignment producing a interactive game for children with Autistic Spectrum Disorder.
It has personally has helped me in my job to understand how autistic people react and how they brains process different things. I decided to work with autistic people to try to make a difference in their lives.
I had to research Autistic Spectrum Disorder at the time I don't know a lot about it.
Producing the game made me think was information is important to them and I'm writing it for them and using the right terminology for the individual to learn and understanding.
Receiving a profile of the individual and what they have difficulties with this helped me in planning and developing their game.
I wanted to help and to try to made a difference to individual and support them along the way and help improve there life even it was just a small amount.
The whole group benefited from the main assignment as it would make the group think about how they can make a difference to those peoples lives. I believe most of the group would have taken something away with them.
I believe that I personally was motivated by creating a game as it make me think about how I personally could help and support them with the educational side of there life.
I would think most of the student were motivated and stimulated by creating the game and supporting a individual. Maybe they may have taken something away from this assessment and help someone.
Thank you again
Kind regards
Liam

Appendix 3

Permission Letter

25 May 2004
Dear Parent/Parents or Carer/s,
Re: Software made especially for your child
I am a senior lecturer at the Middlesex University, the School of Computing Science Special Educational Needs Co-ordinator (SENCO) and a parent of an autistic child.
I teach a large number of first year students the Introduction to Multimedia (CMT1066). The students are given an assignment of producing a multimedia educational game for a particular child, from a completely anonymous and confidential Profiles, which has been compiled by the child's teacher/speech and language therapist.
I am also researching, for a PhD; the effects that multimedia software is having therapeutically and educationally on autistic children's verbal language development in four schools. The teachers and speech and language therapists in your child's school have agreed to assist me, with my research by evaluating the software. Following on with an on-going assessment and monitoring the effects the software is having on the children therapeutically and educationally.
This would result in establishing if software can be used as an aid for their verbal language development. By making appropriate modifications to the Profiles, your child will receive on-going appropriate, customised therapeutic and educational software, specifically for your child, at no cost to you or the school.
If you would also like to get involved in this very useful research, the software can also be used by you and your child at home and you can also assist me in assessing and monitoring the effects this is having on your child by keeping an on-going diary which I could supply to you.
I would be very grateful if you could sign below and return to the school as soon as possible. Thank you, in advance, for your cooperation.
Yours faithfully
EStokes
Elizabeth Stokes BSc(Hons.),PgCert(HE)
Snr Lecturer/SENCO
School of Computing Science
Middlesex University
Elizabeth1@mdx.ac.uk
[redacted]
I/We……., the parent/s or carer/s of …… give permission for the on-going software produced by Middlesex University students, made specifically for my child's therapeutic and educational use. This will be assessed and monitored for the PhD research being carried out by Elizabeth Stokes, with the assistance of my child's teacher and/or speech and language therapist.
I/We……....., the parent/s or carer/s of ……..agree to participate in this on-going research, at home by completing diaries, which will be assessed and monitored for the PhD research being carried out by Elizabeth Stokes.

Appendix 4

Chair Institute for Works Based Learning
Ethics Committee

17 December 2015

Copy to
Dr Annette Fillery- Travis
Associate Professor
IWBL

Letter of Ethics Recognition

Dear Elizabeth

Thank you for submitting your documents and working with your adviser Dr Annette Fillery- Travis to ensure that you meet the criteria for the issuing of a letter of ethics recognition relating to your research. A case was made on the basis that you have been supported by your current adviser who was appointed as your previous supervisors were no longer available and the work has been substantially refocused. I have looked at the correspondence from Dr Tracey Cockerton, Chair of the University Ethics Committee and I have spoken to your adviser about the ethical considerations with which you have been engaging throughout your work. The research, which was carried out prior to your current adviser's involvement and which you wish to include in this new work, was under supervision and there is evidence that actions were taken at the time to mitigate any ethical issues. Your adviser has overseen their inclusion into this new work and you have demonstrated through your actions and in the write up that no ethical considerations have been compromised.

You have now sent me the following documents which I requested in my correspondence with your adviser on the 5 November 2015

1. A brief signed statement from you that you support this request and the reasons why.
2. A signed statement from the candidate with a brief description of the research and the steps taken to mitigate any potential ethical issues.

I acknowledge that I am satisfied that you meet the requirements for this letter of ethics recognition.

[redacted]

Dr Kate Maguire Chair IWBL Ethics Committee

Appendix 5

Extended profile

Profile End-User:
First Name (only)……..to be included/not to be included in the software
VERBAL or NON VERBAL?
Age: Gender: Ethnic origin:
Tick appropriately 1=Severe - 5=Mild, not applicable= n/a)
Learning Difficulty (Please stated MLD/SLD/DD/Other)
Medical Conditions (Please state e.g. ASD, Epilepsy,
Dyslexia, Asperger Syndrome, Down Syndrome, Cerebral Palsy,
Fine + Gross Motor Co-Ordination, Physical Disabilities, Auditory difficulties, visual difficulties
Learning Difficulty (Please stated MLD/SLD/DD/Other)
Medical Conditions (Please state e.g. ASD, Epilepsy, Dyslexia, Asperger Syndrome, Down Syndrome, Cerebral Palsy,
Fine + Gross Motor Co-Ordination, Physical Disabilities, Auditory difficulties, visual difficulties
BEHAVIOUR e.g. challenging, inappropriate, disruptive, obsessive, ritualistic, repetitive, attention span ? (state and give example/s)
Behavioural interventions used? (Explain briefly)
Section A - PROFILE -
Tick appropriately the pupils abilities in each of the categories
Tick appropriately 1=Excellent- 5=Poor n/a=not applicable, Y/N= Yes/No
Social Communication e.g. Verbal language (vocabulary), articulation, non-functional communication (vocal sounds) sings/says rhymes, Echolalia
Suggestions to include in software
Low tech AAC systems
Communication book
Sign language
Makaton to be included in software ?
Which signs to add to software?
Uses symbols? (TEACCH/PECS)
Which symbols to add to software
Gestures
Points
Uses more if……
Facial/Body language used
Uses more if……
Receptive + Comprehensive skills?

Suggestions to include in software
Social Interaction/skills difficulties (e.g. Initiates social interaction with adults/peers>, eye contact?, Turn-taking?
Interacts with familiar adults/adults/familiar peers/peers?
Able to join in with pair/group activities ?
Able to take the lead? Can follow the lead? Leads adults/peers?
Able to copy
Able to/take joking and teasing
Sniffs adults/peers, Strokes adults/peers, Jumps on adults/peers?
Likes adults to direct, Relates better with adults
Have developed friendship with familiar adults+Familiar peers
Acceptance of compliments and success
Negotiating skills
Suggestions to include in software
Rigidity of Thought + Imagination difficulties
Use of imagination through own interests, through symbolic play
Understanding emotion/feelings/thoughts of others
Shows empathy
Understanding of facial expression of others?
Plays on their own + alongside adults/peers
Independence/Self Help skills:
Suggestions for software:
Play
Prefers to play on their own
Inside (board games)/outside ball) games
Role Play
Hide and seek
Line up bricks, dice, cars
Modelling
Imagination
Circle Time ?
Electronic/computerised games e.g. PlayStation/Gameboy/Computer games
Other please state
Suggestions to include in software
High Tech AAC Systems
Electronic Communication aid used
COMPUTER SKILLS
Will be using PC/MAC/Other
Able/Unable/to use: Qwerty Keyboard
Able/Unable/to use: Headphones
Able/Unable/to use: mic

Mouse skills
Software
Turn-taking with peers/adults using the PC
Software for working individually/pairs/group/with teacher/parent/SALT
Cause and effect software needed
Software enjoyed at home/school:
Type of software enjoyed by student…
Modality (senses) favoured by child:
Tactile learner (Prefers to touch - needs interactivity)
Auditory leaner (Prefers to listen - needs sound cues)
Visual Learner Prefers to looking (needs visual cues)
Suggestions to include in software
Channels of Communication/Elements of multimedia favoured by student
Text/Words (Size e.g. Large/small)
No of words to used ……
Lower case only/upper case only/ both
2-4 letter words, longer than 5 letter words
Other
Sound
Pitch/tone
Loud/Soft
Type of music…
Sound effects to include
Other
Graphics + Animation
Photographs
Drawing/ Charts/maps/diagrams
Disney/ Thomas-the-Tank Engine characters
Other
Videos to be added to software
Suggestions to include in software
Mediums enjoyed
Computer/Books/TV/Video Other please state
EDUCATIONAL
Reading level in relation to
(with the help of: own/adults/peers/objects/symbols/signs)
Comprehension Level in relation to Maths:
Elaborated 5-14 Curriculum/Pscales/National Curriculum in relation to Maths
(Levels reached in relation to Maths)
Maths Abilities

Maths Weaknesses
Maths Software
Turn-taking with peers/adults using the PC
Software for working individually/pairs/group/with teacher/parent/SALT
Cause and effect software needed
Software enjoyed at home/school:
Type of software enjoyed by student…n/a
Maths suggestions to include in software fractions
ICT abilities and weaknesses It abilities are great and excel needs work
Mouse and keyboard skills
Educational classroom interventions being used for Maths ?
Maths software Tried ? Successful or not please explain
Strengths:
Weaknesses:
Likes (e.g. state…. Colours?, smells?, music?, jigsaw puzzles?, trains?, balls?, Disney? Thomas? Water? Sand?
TV programmes, videos, animals?- transport?-skills/interests? Lining things up (state what?) enjoys spinning (state what?)., tearing books, flapping
Dislikes (e.g. state…..Colours?, smells?, music?, jigsaw puzzles?, trains?, balls, TV programmes, videos, transport? -animals? Noise? Shops? Traffic? Change? Transition? Proximity)
Personal skills and interests ?
Suggested e.g. (delete if not required) numeracy skills, addition, subtraction, multiplication, division, shapes, colours,
Opposites, Matching, stories, laying the table, shopping, problem solving (give examples)
Additional information